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No. 90

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LARGE R&D PROJECTS UPDATE

Tokyo KOGYO GIJUTSU [Industrial Science and Technology] in Japanese Vol 20 No 8, Aug 79 pp 16-63, 66-73, 75-76; a monthly publication of the Agency of Industrial Science and Technology, Ministry of International Trade and Industry

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SPECIAL ISSUE ON LARGE R&D PROJECTS

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 p 16

[Article by Kazuo Fujimoto, Technology Counselor, General Affairs Department, Agency of Industrial Science and Technology: "Today's Topics, Tomorrow's Developments"]

[Text] At the present time, Japan is burdened with a serious oil problem, and it is in a situation in which there is need for accumulation of knowledge with regard to greater development of industrial structure, removal of the factors limiting growth, and assurance of security, and effective measures along these lines are greatly in order.

The item that will fulfill these demands, enhance Japan's international competitive strength, and serve as the foundation for materially improving its people's living and enable harmonious development of its national economy is, above any other single factor, innovative technological development.

The Large Project System of the Agency of Science and Technology was initiated in 1966 with the three projects "Super High Performance Electronic Computer," "Desulfurization Technology," and "Magnetohydrodynamic Power Generation" (MHD) with an annual budget of one billion yen. Since then, 15 projects have been started, and this program has grown to the stage that the JFY 1979 agenda lists eight projects funded at about 15 billion yen. In this 15-year period, the government has put forth a total of about 100 billion yen, there have been about 400 industrial property items that have been acquired, and the income from patents and other industrial rights have totaled more than 200 million yen. It is expected that the spin-off from this system will continue to increase in the future.

Looking at this program in more specific manner, research and development on six of these projects had been terminated prior to the end of the last Japanese fiscal year. Among these projects is the "Superhigh Performance Electronic Computer" project which has played a major role in the firm establishment of Japan's electronic computer industry. In addition, the "Sea Water Desalination and Utilization of Byproducts" project has compiled a record of exports centered mainly on the Near and Middle East regions.

In addition to those results which were directly assessable, there were many areas which could not be directly assessed but which contributed greatly to improvement in technology of related areas.

Looking back to the time this Large Project System was initiated, Japan in April 1964 joined the eight countries of the IMF, and Japan's free enterprise economy advanced in rapid tempo. On the other hand, the technological level at that time had made rapid advances through assimilation and absorption of technology imported from the western world, and the desire and effort to conduct innovative technology and development was lacking. At the same time, there was a desire for measures to provide funds for research and development directed at large scale production and intercollegiate and interindustry [cooperations]. This is the background to this present system which ties together the country's funds to the research and development capabilities of private industry.

Since then, the new energy technology research and development system (Sunshine Program) was initiated in 1974 and the energy conservation research and development (Moonlight Program) was initiated in 1978 both in response to the needs of their times. It may be said that these systems have served as the frontrunners of large scale research and development by the Ministry of International Trade and Industry.

The subjects that we will be faced with in the future include, on an international level, the rise in cost of resources and energy, increased interdependency of the economies of different countries, and the nurturing of developing countries. On a domestic front, there are the problems of meeting the demand for a higher level industrial structure, complying with social needs, preparing for the succeeding generation of technological innovations, and assuring security.

To be sure, it is said that the peripheral environment which envelopes the large project system is also undergoing large changes, but "the object of the large project system is to take cognizance of the importance of conducting research and development to raise the people's economy by a program in which the nation becomes the backbone of the research and development efforts and underwrites the entire cost of promoting the program and based on a system for close cooperation of industrial and academic circles, engages in promoting planned and efficient research and development, and thereby upgrading the country's industrial structure, strengthening its international competitive power, developing natural resources in more rational manner, and striving to prevent industrial pollution. At the same time, a spectacular upgrading of the technological level of the nation's industries will be targeted." It is thought that this system will benefit from the introduction of new viewpoints in addition to the concepts that were incorporated at the time of inception. I pray that this system will continually develop with the understanding and support of all concerned.

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LARGE PROJECT SYSTEM AND ITS OPERATION

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 17-19

[Article by Koji Ota, (Former) Comprehensive R and D Officer, General Affairs Department, AIST]

[Text] The Large Industrial Technology Research and Development System (commonly referred to as the Large Project System) was initiated in JFY 1966. This system is designed to handle certain projects which involve large type industrial technology deemed urgent and necessary to the people's economy, which require vast sums of money and long term to bring to fruition, and which entail such great risks such that private industry cannot hope to develop in which the nation bears the load of providing the necessary funds, maintains close cooperative system with industrial and academic circles, and develops technology to contribute to resources development, development of environmental protection technology, and improve the people's living standards and well being through planned and efficient promotion of research and technology of innovative and leading technology.

Research and development by this system is centered on the Agency of Industrial Science and Technology under the Ministry of International Trade and Industry and is promoted through a system incorporating the industrial world, the academic world, and subordinate or related ministries and agencies. The selection of subject themes, establishment of the research and development plan for each them, and designation of the plans of execution for each year are items on which the Industrial Technology Council which is an advisory organ of the Ministry of International Trade and Industry holds hearings each year through instruments such as the Large Technology Development Section. A research and development liaison council has been established consisting of academic researchers in related fields and research and development managers, and this group enters into comprehensive promotion of the execution of the project. The makeup of the administrative front of this research and development promotion involves the research and development officer in charge for every project functioning under the director of the Agency of Industrial Science and Technology. There is also an overall research and development officer who coordinates efforts between projects. He looks after the management details while the technology councillor conducts all inclusive administration over the entire area of operations covered by the project (see Figure 1).

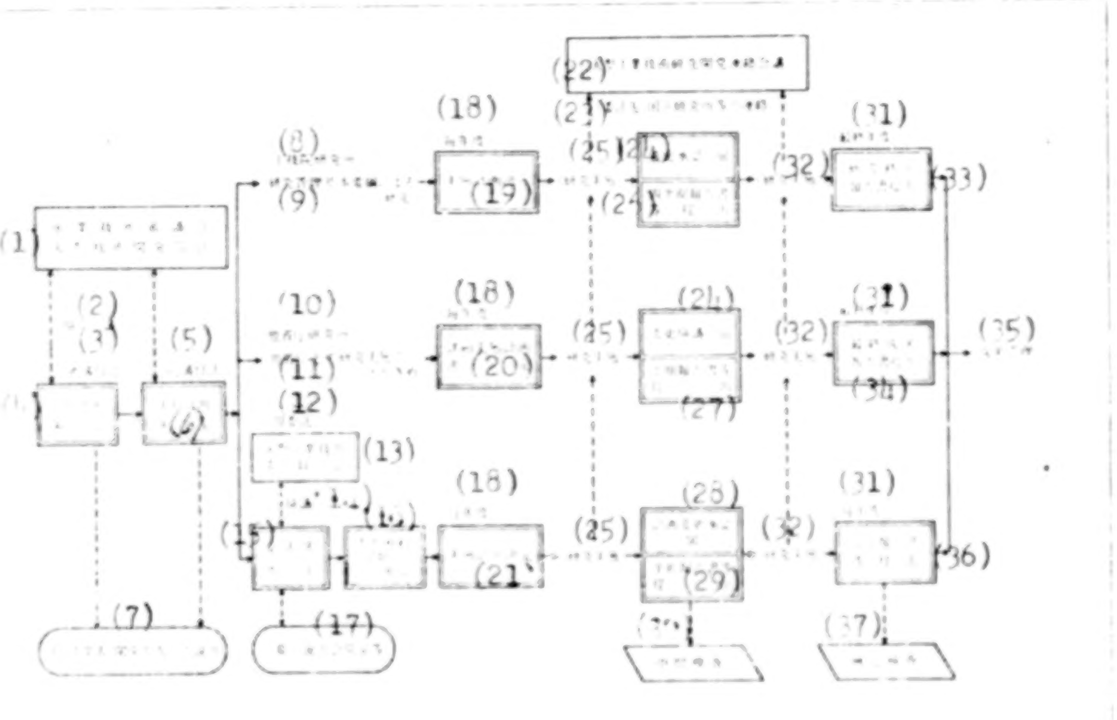

Figure 1. Makeup of Large Industrial Technology Research and Development Operating Mechanism

Key: (1) Industrial Technology Council, Large Technology Development
(2) Subsection
(2) deliberation
(3) ministry conference for committal
(4) layout of basic plan
(5) ministry conference for committal
(6) layout of actual plan
(7) press release, explanation to related areas
(8) (AIST laboratories)
(9) research under basic guidelines of research management
(10) laboratories of other ministries and agencies
(11) establishing research execution by other ministries and agencies
(12) research entrusted to private sources
(13) Large Industrial Technology Committee
(14) deliberation
(15) selection of contractors
(16) signing of contracts (including development plan)
(17) holding public hearings, explanatory sessions, etc.
(18) each JFY
(19) setting up executional plan
(20) setting up detailed plan of execution

[key continued on following page]

[key continued from preceding page]

(21) setting up executional plan
(22) Large Industrial Technology R and D Liaison Council
(23) liaison between contractors and national laboratories
(24) approval and reporting of changes
(25) execution of research
(26) submitting quarterly reports, etc.
(27) submitting semi-annual reports, etc.
(28) approval and submission of changes in plans
(29) setting up executional plan
(30) interim inspection
(31) final JFY
(32) execution of research
(33) end of research submission of report
(34) submission of reports on final results
(35) management of results
(36) submission of completed reports
(37) decision inspection

The themes selected for research and development include a number of themes which today demand urgent research and development, and this system uses the following selection standards. A theme must fulfill every one of these items before it can be selected as a theme for development.

1) Research and development on the technology in question is extremely important to raising the level of the industrial structure, strengthening international competitive power, developing rational handling of natural resources, or preventing industrial pollution.

2) It is a technology of a leading nature or with popular adoption potential and whose research and development will contribute greatly to the improvement of industrial technology.

3) Research and development on said technology will require vast sums of money, a long term to complete, and also entail considerable risk making it beyond the capabilities of the industrial world to conduct the research and development.

4) The establishment of a developmental target for research and development is possible, and there is promise that there are technological pathways to realize the objective.

5) Research and development will require the coordinated efforts of the research and development capabilities of government, industrial, and academic circles.

Table 1. Outline of JFY 1979 Large Project Budget

	(1) プロジェクト名	研究開発期間 (13)	研究開発総額 (27)	53年度予算額 (31)	54年度予算額 (32)
	(4) パターン情報処理システム	(14) 46~55年度	(28) 百万円 約220	(31) 百万円 2,514	(33) 百万円 2,0[illegible]3
	(5) 高温還元ガス利用による直接製鉄	(15) 48~55年度	(29) 約131	1,1[illegible]	1,5[illegible]3
	(6) 自動車総合管制技術	(15) 48~54年度	(29) 約73	[illegible]	153
継	[illegible]を原料とするオレフィンの製造法	(17) 50~56年度	(29) 約110	1,[illegible]	2,[illegible]31
(2)	(8) 航空機用ジェットエンジン	(18) 51~57年度（第二期計画） (19) 46~50年度（第一期計画）約69億円	(29) 約185	2,481	3,387
	(9) 資源再利用技術システム	(20) 51~57年度（第二期計画） (21) 48~50年度（第一期計画）約13億円	(29) 約140	2,427	[illegible]
続	(10) 超高性能レーザー応用複合生産システム	(22) 52~58年度	(29) 約130	[illegible]	2,272
	(11) 海底石油生産システム	(23) 53~59年度	(29) 約150	71	(34) 124 債(1,078)
(3) 新規	(12) 光応用計測制御システム	(24) 54~61年度	(29) 約200	–	51
	(25) 事務費・調査費等			174	170
	(26) 合　　計			15,852	14,814 (34) 債(1,078)

(35) プロジェクトの概要	(45) 54年度の主要研究開発計画
文字、図形、物体、音声等のパターン情報をコンピューターが認識し、処理することができる技術の研究開発 (36)	総合システム・プロトタイプ（情報認識部、情報処理部、システム制御部、情報伝送部、情報蓄積部からなる。）を完成させる。 (46)
製鉄に[illegible]高温ガス炉からの[illegible]近い将来開発が予定される多目的高温ガス炉の熱エネルギーを製鉄プロセスに利用するクローズドシステムを目指した直接製鉄技術の研究開発 (37)	53年度に引続き、高温熱交換器及び還元ガス製造装置（水蒸気改質装置及びヒーター・ガス化装置）の試験プラントによる運転研究を継続して行い、それぞれのシステムプロセスを確立するとともに、超耐熱合金、高温断熱材料、還元鉄製造装置とトータルシステムの研究開発を進め、研究開発目標を達成する (47)
電子制御システムと[illegible]を[illegible]して交通流を制御することにより、交通の[illegible]、交通事故の減少、[illegible]等を目的とする総合交通制御技術の研究開発 (38)	54年度はプロジェクトの終了にあたり、プロジェクトの総合評価を実施する。また、そのための主要都市の道路ネットワークにおける実用システムの効果についての総合研究を行うとともに、研究実験設備の撤去処分等を行う。 (48)
[illegible]いわゆるアスファルト[illegible]オレフィン（エチレン、プロピレン等の総称）[illegible]を製造する技術の研究開発 (39)	53年度に引続き、パイロットプラントの建設（機械装置等の製作及び据付）を進め、これを完了し、さらにパイロットプラントの運転研究を行い、またスケールアップ等に関する基礎的研究、本技術の実用化に対処するための本技術の経済性評価等の研究を上記研究と並行して進める。 (49)
[illegible] (40)	騒音、有害排気の低減技術と高性能化等の研究を行うとともに、53年度に引続き全試作エンジンを用いて、地上性能試験、低サイクル疲労試験を行い、さらに第1期試作エンジンによる地上高空性能試験を実施する。また第2次試作エンジンの組立を終了し試験運転に着手する。 (50)
[illegible] (41)	[illegible]パイロットプラントの[illegible]を終え、[illegible]のための研究を行う。 (51)
[illegible] (42)	53年度までの成果を踏まえ、トータルシステムでは、各サブシステム間の[illegible]を図るとともに、[illegible]、設計[illegible]、試験装置を設計・試作し、各種試験を実施する。 (52)
[illegible] (43)	（開発項目概要） ・[illegible] ・[illegible] ・[illegible]各サブシステムを総合化するための[illegible]の研究開発を行う。 ・[illegible]試験等を実施する。 (53)
[illegible] (44)	プロジェクト・トータルシステム、情報伝達サブシステム及び制御サブシステムの各サブシステムについて基本設計に着手する。 (54)

(55) 注 1. [illegible]

[Key to Table 1 on preceding pages]

(1) Name of project
(2) Continuing project
(3) new project
(4) pattern information processing system
(5) direct steel making using high temperature reducing gas
(6) comprehensive automobile control technology
(7) method of producing olefins using heavy oil raw material
(8) jet engines for airplanes
(9) resources reutilization technology system
(10) modular production system applying superhigh performance laser
(11) sea bottom oil production system
(12) optical application instrumentation and control system
(13) research and development period
(14) JFY 1971-80
(15) JFY 1973-79
(16) JFY 1973-79
(17) JFY 1975-81
(18) JFY 1976-81, second stage plan
(19) JFY 1971-75, first stage plan, about 6.9 billion yen
(20) JFY 1976-82, second stage plan
(21) JFY 1973-75, first stage plant, about 1.3 billion yen
(22) JFY 1977-83
(23) JFY 1978-84
(24) JFY 1979-86
(25) administrative costs, coordination costs, etc.
(26) total
(27) total sum for research and development
(28) (100 million yen) about 22 billion
(29) about..... x 10^8 yen
(30) JFY 1978 budget
(31) (million yen)
(32) JFY 1979 budget
(33) (million yen)
(34) (note) [see 58]
(35) outline of project
(36) research and development on technology in which a computer recognizes and processes characters, figures, objects, and sound type pattern information
(37) research and development on direct steel making technology aimed at a closed system utilizing thermal energy from a multiple purpose high temperature gas reactor which is expected to be developed in the near future in order to resolve the pollution problem accompanying steel making and relieve this nation from dependence on coking coal.
(38) research and development on all inclusive control technology to resolve traffic jam situations, reduce pollution from automobiles, and lower the accident rate by tying together a roadside information system to individual automobiles and control traffic flow.
(39) research and development on producing high-added-value olefins (such as ethylene, prophylene used as raw material for the manufacture of synthetic resins, synthetic rubber, and synthetic fiber) starting from oil fraction of high sulfur content which is difficult to desulfurize

(39) Research and development on producing high-added-value olefins (such as ethylene, propylene used as raw material for the manufacture of synthetic resins, synthetic rubber, and synthetic fiber) starting from oil fraction of high sulfur content which is difficult to desulfurize (the so-called asphalt fraction)

(40) Research and development on high performance jet engine for commercial aviation use which is associated with low pollution effects such as atmospheric pollution including noise and emissions, high overall efficiency, able to withstand frequent takeoffs and landings, and easy to maintain and service

(41) Research and development on a technological system for urban solid waste disposal which is aimed at effective use of resources and smooth handling of solid urban wastes through the regeneration and reutilization of resources

(42) Research and development on a modular production system which can produce a diversity of machined parts, each of small quantity, from metallic materials through an integrated system which is flexible and rapid

(43) Research and development on a sea bottom oil production system which enables effective production of oil from sea bottoms at great depths (more than 300 m deep) and which can be utilized to develop the ocean areas about Japan (without adverse effects to the fishing industry and capable of producing oil from small-scale oil sources)

(44) Research and development on an optical instrumentation centralized monitoring, and control system which can cope with adverse conditions such as poor environmental conditions including bad electromagnetic conditions and monitor large volumes of information generated within a given area such as a large industrial park or a large plant

(45) Major research and development plans for JFY 1979

(46) Complete overall system prototype (information recognition system, computer processing section, system control section, information transmission section, and information storage section)

(47) Continuing from JFY 1978, conduct research and development on operating an experimental plant including high temperature heat exchangers and reducing gas production facility (steam reformer and pitch gasification facility), establish the respective system processes, and develop the total system including super heat resistant alloys, high temperature insulating materials, and reduced-iron production facility

(48) Conduct overall evaluation of project in anticipation of terminating this project in JFY 1979. Conduct survey research on the effectiveness of the practical system when used on the highway network of major cities and plan to dismantle and remove the experimental research facilities

(49) Continuing from JFY 1978, promote construction of pilot plant (including installation of machine equipment and completing remaining site construction), complete this phase, and conduct pilot plant test operation. In addition, promote research on plans and designs for scaling up and conduct research on the analysis of the properties of the heavy oils in order to facilitate handling of a variety of heavy oils

(50) Conduct research aimed at lowering noise and discharging of toxic gases, continue assembly of a primary test engine from the previous year, conduct long term endurance tests and low cycle fatigue tests, and conduct experiments to study the ingestion of water and birds using the first-stage test engine. Complete basic design of second test engine and start on detailed design.

(51) Pilot plant construction of the "material recovery type" (recovery of oils, paper pulp, and fuel gas from urban waste) facility will be completed, adjustment operation will be conducted, and comprehensive operational research will be conducted. Where the "energy recovery type" (produce fuel oil and methane) is concerned, research will be conducted to improve energy efficiency

(52) Based on the basic designs drawn up to the preceding year, control modes between subsystems will be planned on the total system to improve the compatability of the system, and structural analysis of potential fabrication products by this system will be made. In addition, milling and finishing technology, unit forming and finishing technology, laser application technology, automated assembly technology, automated diagnostic technology, and design control technology will be studied along the lines of experimental research on structural characteristics of each element technology, and parts for important different mechanisms (compound milling mechanism, free forming mechanism, automated assembly mechanism, laser oscillator, etc.) will be test fabricated following basic design, and design and test fabrication of an experimental facility will be started

(53) [Development fund related items]

Experiments to obtain basic data necessary to the design of a facility to detect the location and degree of pipeline leaks and damage will be conducted.

Experiments to collect basic data necessary to design of an approach control mechanism to enable approach to fixed underwater objects will be conducted

[Coal and Petroleum Special Account]

Research and development on engineering and operating technology to integrate each subsystem into the total system will be conducted.

Model experiments, computer simulations, and materials experiments will be conducted in order to complete detailed design of subsystems

(54) Basic research will be initiated on instrumentation subsystems, information transmission subsystems, and control subsystems.

(55) [Note] 1,078 is the figure contained in the Coal and Petroleum Special Account budget proposal.

Research on the themes selected in the manner described above is divided into that performed by the experimental laboratories under the jurisdiction of the Agency of Industrial Science and Technology and other related ministries and agencies and research entrusted to private industry. Each contractor follows the basic plan of the research theme, and there is wide canvas of industries which desire to receive grants for research and development (applications are issued prior to initiation of research and development through a Ministry of International Trade and Industry announcement). These applications are judged by a Large Industrial Technology Committee comprised of personnel from the Agency of Industrial Science and Technology, experimental laboratories, and Ministry of International Industry and Trade before a decision is made.

At the present time, research and development along the lines of the themes listed in Table 1 are under way, and it is expected that research and development will be initiated in JFY 1979 on the new theme "Optical Applications, Instrumentation and Control System."

2267
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PATTERN INFORMATION PROCESSING SYSTEM

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 20-23

[Article by Akira Konno, Office of the R and D Officer, AIST]

[Text] Need for Research and Development

Accompanying the development of information oriented society, the need and expectations for information processing systems have suddenly increased not only in the areas of science and technology and business management but in a wide field including production control, information management, medicine, education, and transportation.

What is turning out to be a bottleneck to the need cited above has been the inability of information processing systems of the past to hangle directly various types of pattern information such as characteris, figures, objects, and sound.

This is why there is the need for directly inputing pattern information, for developing a recognition system that is an information processing system in order to alleviate this situation. (See Table 1).

Table 1. Comparison Between Present Computer Information Processing System and Pattern Information Processing System

	Present electronic computer information processing system	Pattern information processing system
target information	mainly numbers	characters, shapes, objects, sound, etc.
method of inputing external information	manual input (such as key punching); shapes are designated by name and input manually	direct input as is, without manual input
computing, processing decision, display	time-sequence one-dimensional handling (successive processing)	2-dimensional handling (parallel processing)
memory	write-in and read-out by address	write-in and read-out according to generic nature of pattern (associative memory, etc.)

In foreign countries, the computer makers head a list of agencies such as universities and research organs engaged in earnest development of pattern information processing systems, and it is anticipated that this subject may become the focal topic in information processing systems in the 1980s.

Looking at this present situation, unless Japan takes drastic measures, it will end up behind foreign firms in this field, and this would surely have a major influence on Japan's information processing industry.

To deal with this situation, Japan decided on active promotion of research and development aimed at information processing systems that should become practical sometime during the early 1980s.

Targets of research and Development

This project is intended to develop a pattern information processing system of processing speed and cost in the practical range that will possess the following capabilities.

1) Be able to input and recognize pattern information directly. At the same time, it will be capable of storing, computing, and processing for output the information as needed.

2) It will be able to utilize the various properties of natural spoken language and process basic, simple sentences.

3) It will possess new capabilities such as parallel processing, association, and learning as part of its computer processing modes.

Research and Development Plan

This project was planned for a 10-year period starting in JFY 1971. The total development cost is to be about 22 billion yen.

This project is being promoted as four items: 1) research on a pattern recognition mode including separate recognition and processing of characters, figures, objects, and sound and natural language processing; 2) research on parts and materials; 3) research on an information processing system which possesses the capabilities of parallel processing, association, and learning; and 4) research on an overall system prototype. The first stage will include research on information processing modes and individual recognition modes and new component materials research, and the second stage will take in the results of the first stage and conduct design, production, and performance evaluation of pilot models of the information processing system and the individual recognition systems. At the same time, research will be conducted or even higher level recognition modes. The final stage will be the compilation of all these results to design, build, and evaluate the overall system prototype and thereby complete this project. (See Figure 1).

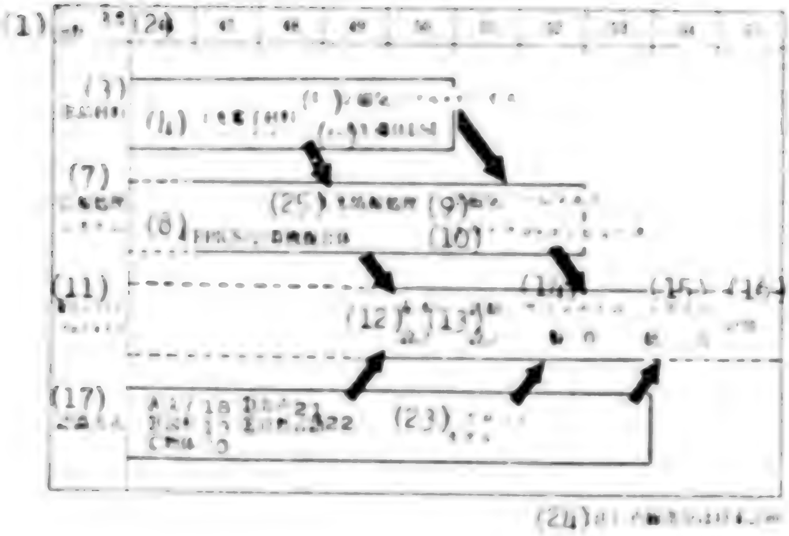

Figure 1. Progress Status of the Overall Plan

Key:
(1) area
(2) JFY 1971 ("46") through 1980 ("55")
(3) parts and materials
(4) photoelectronic material device
(5) magnetic bubble device
(6) semiconductor LSI
(7) information processing system
(8) EPICS/computer composite
(9) magnetic bubble memory
(10) microcomputer
(11) overall system prototype
(12) basic design
(13) detailed design
(14) subsystem manufacture
(15) system unification
(16) evaluation
(17) recognition mode
(18) characters
(19) figures
(20) objects
(21) sound and voice
(22) natural language
(23) pilot model
(24) Note: the broken lines indicate future plans
(25) optical information processing

Research and Development Status

This project has now gone through 8 of its projected 10 years, and research on information processing modes, research on individual recognition modes, and research on parts and materials have been completed. At the present time, the above results are being compiled, and research on the overall system prototype is being promoted.

The following is the research and development status according to separate research items.

1) Research on Pattern Recognition Modes

As far as separate recognition modes for printed characters, handwritten characters, light and dark figures, colored figures, objects, and voice and sound are concerned, the modes and methods for recognition algorithms were essentially established by JFY 1976, and an individual recognition pilot models were test produced as an intermediate result and performance evaluation was conducted. In addition, research on a high level recognition mode is being promoted. (See Table 2 for the performance of the individual recognition pilot models).

Along the lines of research on common software and natural language processing, the efforts up to the present time include development of programming for LISP nonnumeric processing language and research on Japanese text structional analysis.

2) Research on Parts and Materials

Research and development on this subject was initiated in JFY 1971 in which parts and materials to fulfill the initial target objectives such as charge coupled devices, infrared semiconductor laser arrays, magnetic bubble elements, and LSIs were researched and developed. This phase was completed in JFY 1975.

3) Research on Information Processing System

Research on the information processing system was conducted based on the results of the studies on parts and materials. In the area of microcomputers, a one-chip microprocessor (PULCE) with 7,000 gates and a buffer memory with 4 kilobit per chip and main memory of 16 kilobit per chip were combined in the microprocessor system that was test produced in JFY 1977. In the area of magnetic bubble systems, test production of magnetic bubblememory modules, (a 16-megabit magnetic bubble memory incorporating one chip 256 kilobit magnetic bubble memory elements, operated by a 500 KHz rotating magnetic field and a magnetic bubble memory module access time 0.4 millisecond) for a 64 kilobyte high-speed auxiliary memory system incorporating one-chip 78 kilobit magnetic bubble elements were completed in JFY 1977. The former is used as the file memory for the overall system's data base machine while the latter is used as high speed supplementary memory for the overall system's sound and voice recognition subsystem. The optical information processing system including a holographic optical, large capacity file subsystem using infrared semiconductor laser arrays, an optical information search subsystem using optical space modulators, and an optical relightable file subsystem using reversible photosensitive elements was completed in JFY 1977. The holographic optical large capacity file is used as the Japanese words processing machine file.

Table 2. Pilot Model and Prototype Performance Table

		pilot model (actual)	prototype (target)
printed character recognition subsystem	type of character	2,000 printed Kanji	same as left
	size of page	B4 or less	up to A 4
	reading speed	100 characters/sec	same as left
	correct reading rate	98.4%	over 99.9% (includes post processing)
handwritten character recognition subsystem	types of character	10 handwritten numerals, 26 letters, 12 symbols	10 handwritten numerals, 26 letters, 12 symbols, 48 Kana [phonetic symbol
	reading speed	400 characters/sec	same as left
	correct reading rate	99.4%	over 99%
voice recognition subsystem	no. of recognizable words	about 100 words	same as left
	speakers	40 people used as training samples	nonspecific
	ambient noise	up to about 65 phons	level of ordinary room noise (about 75 phons)
	recognition speed	about 1 second	same as left
	no. of phrases output	none	about 200
object recognition subsystem	recognizable objects	rectangular object	same as left
	type of background	complex background	same as left
	recognition speed	about 1 minute	about 10 minutes
dark-light figure recognition subsystem	recognition object	dark-light figure, multi-spectral figure	same as left
	number of differentiations	about 10 types	32 types
	processing time	several seconds per graphic	about 1/3 second
colored figure recognition subsystem	recognition object	colored photos, colored figures	same as left
	processing time	about 1 second for a 128 x 128 colored element figure	about 1 second for a 256 x 256 colored element figure

At the same time, research is underway on a practical on-line joint utilization computer compound system for more vigorous promotion of research and development.

4) Research on Overall System Prototype

Basic design was started in JFY 1975, and the results on the microcomputer system obtained in the studies on information processing systems were taken up to attempt the test production of a prototype incorporating polyprocessor system, parallel computing machines, data base machines, high level language machine, interactive compound terminal processor, and Japanese word processing machine subsystems, which was begun in JFY 1976. In addition, the results on the pilot models completed in JFY 1976 were used in the test production of a prototype incorporating printed character recognition subsystem, handwritten character recognition subsystem, dark-light figure recognition subsystem, colored figure recognition subsystem, object recognition subsystem, and voice and sound recognition subsystem which was initiated. Furthermore, research on a high speed ring but system to enable communication between these subsystems was initiated in JFY 1976 while test production of all prototypes was begun in earnest during JFY 1978. It is planned to complete all test production during this fiscal year, connect all the subsystems to this high speed ring bus, and make functional coordination and adjustments. (See Figure 2).

A comparison between the performances of the pilot model and the prototype for the individual recognition systems is presented in Table 2.

Results of the Research and Development

The infrared semiconductor laser array which can output more than 5,000 hours of coherent light developed by research and development to date has made possible write-in and read-out of holograms. At the same time, a magnetic bubble memory element with 256 kilobits per chip is on the verge of commercial production basis. Other laudable developments include parts and materials such as reversible photosensitive material and space modulation elements.

In the area of pattern recognition systems, better than 99 percent recognition rate has been realized by the printed word, handwritten word, and voice and sound recognition subsystems. These are all eyeopening results.

At the same time, the research and development efforts to date have resulted in applications for more than 390 patent items, and more than 600 presentations have been made on research results before both foreign and Japanese scientific societies. In this manner, this project has made great contributions toward improving Japan's technological level in the pattern information processing technology area.

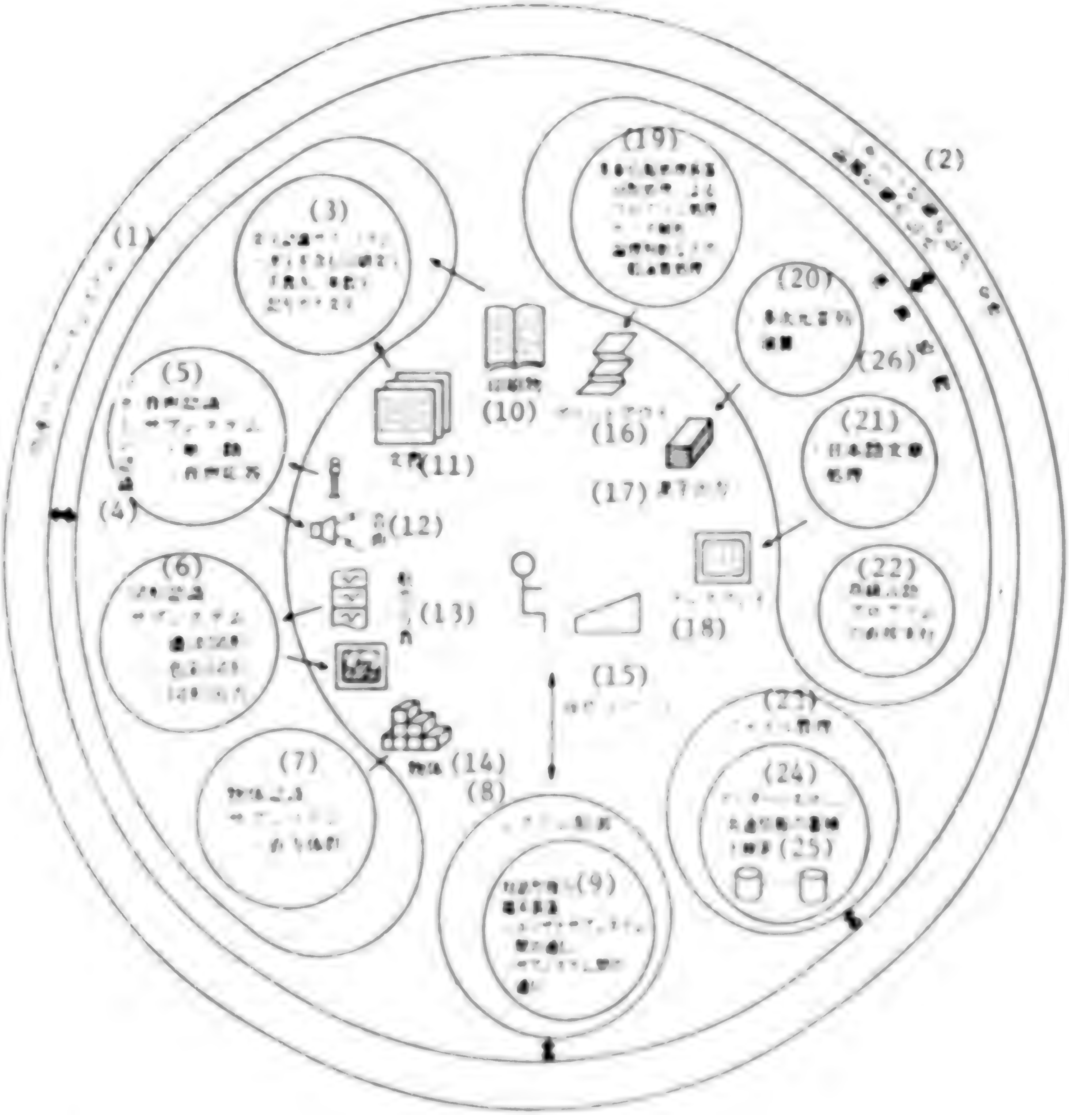

Figure 2. Conceptual Diagram of Overall System Prototype

Key: (1) high speed ring bus system
     (2) transmission of pattern information transmission, exchange, and control information
     (3) character recognition subsystem: printed characters including Kanji, handwritten, English numerals, symbols, Kana
     (4) pattern recognition
     (5) voice recognition subsystem: single words, voice answers
     (6) figure recognition subsystem: dark-light figure, colored figure, graphic output
     (7) object recognition subsystem: rectangular group
     (8) system control

[key continued on following page]

[Key to Figure 2 continued from preceding page]

(9) interactive compound terminal; communication between user and subsystem, communication between subsystems
(10) printed material
(11) compositions
(12) voice
(13) aerial photographs
(14) objects
(15) operating command
(16) printout
(17) Kanji output
(18) display
(19) Multiple information processing device: program processing, data analysis, logic decisions and such general computer processing by means of distributed processing
(20) multivarient parallel computations
(21) Japanese document processing
(22) direct execution of high level language program
(23) file management
(24) data base machine
(25) accumulation and search of common information
(26) computer processing

Future Plans and Anticipated Effects

Present plans call for completing test production of the prototype of the overall system (Figure 2) sometime during JFY 1979 and conducting performance evaluation during JFY 1980.

This overall system prototype will bring to a high level the recognition performance of the different subsystems developed to date by research on the separate recognition modes and demonstrate that vast amounts of information can be handled by recognition and analysis of pattern information at practical cost and quickly.

It is anticipated that the separate recognition systems and the pattern information processing system which binds these systems together in comprehensive and organic manner will be made practical. In addition, the various parts and materials produced by research and development of this project and the information processing modes have brought spectacular developments to Japan's electronic industry technology. Furthermore, the following concepts which can be developed in the future have come into the picture (see Figure 3).

1) Utilization area for character recognition technology

a) Automation of information search

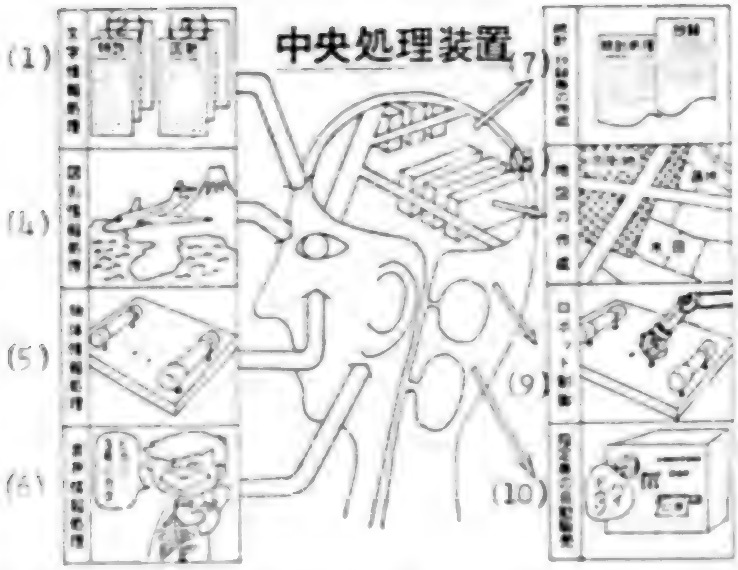

Figure 3. Conceptual Diagram of Areas of Potential Utilization

Key:
(1) character information processing
(2) parents
(3) national census
(4) figure information processing
(5) object information processing
(6) voice information processing
(7) statistical and abstracting operations
(8) construction of maps
(9) robot control
(10) automated ticket purchase

b) Automated Braille translation system
c) Automation of publishing process

2) Utilization areas for figure recognition technology

a) Remote sensing
b) Automated diagnosis and treatment using x-rays and fondus photographs
c) Application to automation

3) Utilization areas for object recognition technology

a) Automated warehousing
b) Automation of goods distribution systems
c) Automation of production systems

4) Utilization areas for sound and voice recognition systems

a) Automated telephone replies, reservation system for tickets, etc.
b) Voice typewriter
c) Information input and operation of electronic computers through voice
d) Education equipment
e) Individual identification system

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RESEARCH ON VOICE RECOGNITION

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 24-25

[Article by Shoichi Yokoyama, Syllogistic Mechanism Research Office, Pattern Information Department, Electrotechnical Laboratory, AIST]

[Text] Ever since the initial days of the launching of the large project Pattern Information Processing System (PIPS), it was the feeling at the Electrotechnical Laboratory that in order to expand the capability of voice recognition from single words uttered by an unspecified speaker to continuous voice recognition of short units would require important contributions from language processing, but the implementation of capability to analyze and extract characteristics at the sound level would be the most important level would be the most important item, and this area has been given greatest attention to date.

When continuous speech is recognized in terms of sound elements or sound phrase units, one of the unresolved problems is the coupling of articulation. Articulation coupling involves the phenomenon of "indolence" [literal] in which there is a transition to the next sound element before the singular voice path pattern is attained which represents the sound element in a passive manner and the phenomenon aside from the above in which the targeted values of the voice path change under the influence of the sound elements before and after. The principal factors here include that in which the voice is formed through the dynamic system of the voice organ of a man and that in which the control of voice is performed in overall manner in a way to realize maximum effect with small energy.

Articulation coupling is difficult to classify from the standpoint of mechanical recognition, and it has also been considered inconvenient to broaden the scope of pattern changes. On the other hand, it is thought that the phenomenon called articulation coupling is the means by which consonants and vocal sound information are transmitted, and there may be need to utilize such information.

By extracting articulation characteristic parameters which represent the shapes of the voice organs (voice track) from the voice wave pattern and the working of the sound organs, the actual state of articulation coupling is being observed at the Electrotechnical Laboratory, and research on a new voice recognition mode based on its construction and capability has been promoted.

When the voice organ is considered to be a type of control system, its properties can be allocated to three sections. These are the properties of the vocal chords, bronchial tubes, and the lungs; the properties of the voice pathway (oral cavity, nasal cavity); and the radiative properties of the lips. The sound elements (a, e, i, etc.) that are the representative units for voice recognition are formed mainly in the voice path. If it were possible to separate the properties of the voice path shape from the voice wave pattern, it will be possible to extract effective information with regard to automatic recognition of voice.

The response to such a complexly intertwined control system usually can be represented by the folding in process of the various components (convolution), and a reverse calculation (deconvolution) has to be performed in order to separate the individual processes. In order to perform deconvolution, it is necessary to understand the properties of the separate control systems, and an attempt has been made at the Electrotechnical Laboratory to modelize the vocal chord wave characteristics including the radiative properties to separate the properties of the voice path shape.

That is to say, in the case of the usual vowel voiced sound (this source of sound is in the glottis where vibration of the vocal chords vibrate the voice path to make the sound and includes vowels, semivowels, and a portion of the audible consonants), the outline of the power spectrum obtained in the voice analysis is considered to be the properties of the vocal chord waves including radiative properties, and the model was created on the basis that these are made up of low-order linear systems. After estimating these properties through a combination with a self regression model, a filter with inverse characteristics was used to remove the vocal chord wave characteristics, and the power spectral outline of the voice wave was smoothed out. This operation (accommodation reverse filter method) made possible the realization of a product with properties close to those of the voice path, and application of the linear prediction method made possible the extraction of the cross-sectional structure of the voice path.

Spectral analysis conducted in the past considered the entire voice path as a black box, and attention was directed at the relationship between input and output. In contrast, the voice path pattern involves entering the internal construction of the formation process to make observations.

The method of separating voice path properties by the accommodation reverse filter method can be applied to linear prediction analysis or correlation analysis in addition to voice path shape estimations. The usual voice analysis is conducted without separating voice path characteristics or sound source characteristics so that the correlation factor is greatly influenced by the slope of the spectrum. The smoothing out of this slope in accommodative manner removes peripheral noise which varies in timewise manner, assures dynamic range for the analysis, and enhances the analytical precision in the high value regions. In addition it enables separation of the sound source characteristics in approximate manner to have the effect of normalizing speaker factors.

Since the shape of this cross-sectional area is obtained as a relative value, there is need to tie in with the working of actual articulation organs (forward and backward movement of the tongue, opening and closing of the jaw, etc.), and to construct a model. This is the articulation model, and research is being pursued using a model with the tongue being approximated by a round cylinder (the forward and rear sections use separate cylinders for consonants as will be discussed later).

The discussion above was directed at vowel sounds. A separate method becomes necessary to treat plosives (/p,t,b,g/), nasals (/m/,/n/), and fricatives (/s/). When seen from the standpoint of the organ involved, the sound source for nasals is in the glottis section, and it is thought that the sound reverbrating organ is divided into the two sections of voice path and nasal cavity (the latter essentially remains unchanged in shape). In the case of plosive sounds, the sound origin is thought to be the lips or the teeth section while the origin of fricatives is in the voice pathway between the tongue and upper jaw. Recent trends treat the enunciation of vocal sounds other than vowels is a systematic manner through voice synthesis, but difficulties still are experienced as far as voice recognition is concerned, and there is no other recourse but to compile research on each individual case.

For example, the autoregression model (with only the extremes) which is considered effective method for voice analysis is combined with the transitory flat type model (with only zero) to make up the so-called ARMA model is said to be effective in handling nasal sounds. On the other hand, there are many problems in the area of repeated computations and stability when this model is compared to the autoregression model. Research is being conducted at the Electrotechnical Laboratory to bypass the power spectral region and adopt a method for using the direct time region in order to provide stability to this model.

In addition, the plosives Ba, Ta, and Ka are very rapid phenomena, and these are difficult to capture unless a high density of analysis in the time direction is created, and these are also easily influenced by the vowels which follow. Research also is being conducted on dynamic pattern treatment method and effective standard pattern construction method when these have to be discriminated.

In order to efficiently analyze continuous speech through a combination of the various analytical methods discussed above, it is necessary to judge beforehand whether the input sound is vocal, nonvocal, or plosive and then apply an analysis suited to that sound. In other words, the so-called accommodative type voice analysis becomes necessary. A system in which analytical conditions suitable for extracting characteristics of the input voice in accommodative manner are selected to facilitate voice path shapes and power spectral estimations has been developed at the Electrotechnical Laboratory. This system systematizes the Japanese vowels based on voice path shapes, possesses localized vocal sound discriminating capability, and is being developed to incorporate other new analytical methods.

There are occasions even with continuous speech in which speech which to the human ear seem to be distinctly separated sound elements may display the presence of completely different sound when the "transition" from sound element to sound element is analyzed depending on the phenomenon of articulation coupling that arises in the articulation organ. Research is also being conducted on this transitional behavior directed at just how to treat such occurrences based on the observations of articulation coupling.

At the same time, research is also directed at large speech units such as phrases and sentences at the same time study on short units such as sound elements is being conducted. Vocal accents and intonations are called rhythmic characteristics, and their properties have not yet been adequately elucidated. The Electrotechnical Laboratory is examining the relationship between these properties and breaks and construction through the use of the varying patterns of basic voice frequencies which are thought to have strong tiein with these features by, for example, using broken line approximations to extract the characteristics.

At the present time, research has been limited to the male voice. It is a strange feeling to realize that female and children voices generated with a large difference in length of voice path should sound so pleasing to the human ear. Once a regular assembly of these differences is established, a very powerful tool for handling the speech of an unusual speaker will be available. Work is also being pursued at the Electrotechnical Laboratory on this problem using formalization methods involving reverse asymmetry voice path function estimation method and reverse asymmetry axis.

The above has been a rather haphazard discussion of a number of research subjects, but there are still many areas that were not discussed. The accounts of research to date are given in the English translation "Pattern Information Processing System Survey and Research Report (PIPS Report)" and the Japanese version published as proceedings of the Japan Acoustics Society, and the reader is referred to these reports for the details.

At the present time, research is directed at the characteristics of consonants, particularly the elucidation of the characteristics contributing to the distinction between the nasal sounds Ma and Na, and considerable progress has been made.

The subject of voice recognition (understanding) requires even greater efforts and time even under restricted conditions. It is thought that a practical viewpoint based on experiments and a spirit directed at obtaining the essence of the subject need to be combined to accumulate research results in trustworthy manner in order to achieve the goal. There remain many more problems to be resolved including tying-in with language.

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TECHNOLOGY FOR DIRECT STEELMAKING USING HIGH TEMPERATURE REDUCING GAS

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 p 26

[Article by Masaharu Takamatsu, Office of the R and D Officer, AIST]

[Text] Japan's steelmaking industry has undergone eye opening development since the end of World War II. The foundation for this development includes the enlargement of blast furnaces and the use of LD converters to enable integrated steel production plants, and this technology is given high marks throughout the world. In the area of crude steel production Japan ranks third in the world, behind to the United States and the Soviet Union. In the midst of this expansion in production capacity, the steel industry is engaged in efficient utilization of energy, and the steel industry has been consuming about 17 percent of the total energy consumption of Japan.

If there is any single outstanding problem in the steelmaking industry, it is the problem of raw materials. The principal raw materials required by the steel industry are iron ore and coking coal, and Japan depends on imports from overseas for these sources. In view of the vast resources of iron ore reserves in this world, there does not seem to be the possibility of volume restrictions for a while, although there may be some increases in price.

In another direction, the reserves of coal are much greater than those of the other fossil fuels, oil and natural gas, but coking coal suitable for use in steelmaking amounts to but one-fifth of the total coal deposits. At the same time, there is not as much bias in the location of such coal deposits as is the case of oil; however, here again there is a concentration of these deposits in the United States, the Soviet Union, and China. When viewed from the long term, there is a trend to insufficiency on a world widescale, and some anxiety creeps in with regards to assured supply when the anticipated future increase in demand is considered. The price of this raw material has been increasing sharply just as oil prices since the oil crisis.

The lessening of our dependence on coking coal and diversification of energy resources is an urgent problem for a country of Japan's predicament which is so poor in natural resources. Furthermore, nuclear energy which is being promoted as an energy substitute for oil presently is used only in electric power generation. It is necessary to consider the application of process heat if the share of nuclear energy in the overall energy picture is to be increased.

Nuclear energy steelmaking is the marriage between the conversion of steelmaking dependence to sources other than fossil fuels and the application of nuclear energy to areas other than electric power generation. That is to say, nuclear power steelmaking involves the use of heat from a nuclear reactor to provide reducing gas raw material which will be available for long period at low cost--reduced pressure residual oil (asphalt)--to generate the reducing gas.

The Agency of Industrial Science and Technology took up this project as one of the themes of the Large Project System in JFY 1973 with the purpose of reducing dependence on coking coal, promote diversification of energy sources, and lower pollution-causing emissions from blast and converter furnaces. Nuclear steelmaking technology R and D is divided into first and second stages. The objective of the second stage is to complete a direct steelmaking pilot plant which then will be connected to a 50,000 kW thermal output multiple purpose high temperature gas-cooled experimental reactor that is to be constructed by the Japan Atomic Energy Research Institute. The first stage plan covering the 7-year interval between JFY 1973-79 was directed at research and development, and 13.2 billion yen was allocated, to establish the technology necessary for the design, construction, and operation of this pilot plant. Research and development on the total system for this plant and its principal elements technology is being promoted to this end.

Since technology covering a wide area is incorporated into this project, the Nuclear Energy Steelmaking Technology Cooperative was established in 1973 to serve as the organ to effectively execute this plan. A contract was drawn up with the Agency of Science and Technology, and research and development is being promoted. At the same time, the National Research Institute for Metals under the Agency of Science and Technology is participating in this project as a government research organ and is conducting research on super heat resistant alloys.

Research on the utilization of nuclear heat as process heat is under way in foreign countries, but Japan as yet is the only country in which hardware research of the level directed at nuclear steelmaking is being conducted. West Germany has expressed interest in the high temperature heat exchange system, reducing gas production facility, and the results obtained with super heat resistant alloys developed by this project and has requested participation in cooperative research.

In the past, Japan has actively promoted import of technology to bring itself up to today's status of a leading industrial country, but it seems that it will have to develop technology of a leading nature worldwide from here on. This is one of the reasons there are such great hopes for research and development on this nuclear power steelmaking project. Continuing from the first stage with its abundant results, there is need to actively promote the second stage plan for docking with the experimental reactor together with the development of the reactor itself.

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RESEARCH ON HEAT RESISTANT ALLOYS

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 27-29

[Article by Toru Watanabe, National Research Institute for Metals, Science and Technology Agency]

[Text] This paper will discuss heat resistant alloys used in the system to produce iron by the reduction of iron oxide using high temperature reducing gas produced by the utilization of the heat carried by helium gas from a high temperature gas-cooled reactor. The high temperature helium gas exiting from a nuclear reactor is under the very severe conditions of 1,000°C and 40 atmospheres pressure. As a result, this system uses this gas to heat another batch of helium gas, partitioned into a separate system from the primary helium, to 950°C through the medium of an intermediate heat exchanger. This secondary high temperature helium gas is then used to heat the steam necessary in the production of high temperature reducing gas from reduced pressure residual oil and then heating this reducing gas to the necessary temperature. This heating is performed with heat exchangers in which gas passing through pipes are heated from the outside. In order to attain the targeted temperature, the material making up these pipes must not only be resistant to high temperature but also be able to perform for long periods without being corroded by impurities in the 1,000°C helium gas (H_2O, H_2, CO, CO_2, etc.), high temperature steam, and reducing gas. In order to develop heat resistant alloys with the properties described above, the first objective in this project was the development of material for the intermediate heat exchanger that can withstand 1 kg/mm^2 stress when exposed to 1,000°C helium, be used for more than 50,000 hours, can be machined to 5 mm thickness and 25 mm outer diameter, and can be welded.

To this end the Agency of Industrial Science and Technology formed a super heat resistant alloy working group comprised of experienced and academic people and industrial representatives, and the effort was initiated in July 1973.

At the same time, the basic policy of this super resistant alloy development was to receive proposals for super heat resistant alloys from several makers of these alloys, particularly those with latent potential for achieving the targeted objectives given above from which those alloys thought to have the greatest potential of fulfilling the desired goal were to be selected.

The national research organ, the National Research Institute for Metals, then was to test the performance of these alloys particularly with respect to creep and compare the different alloys and compile data to serve as standards.

Test Research Items at the National Research Institute for Metals

The following eight items were targeted for study during the first period (JFY 1973-79).

1) Creep rupture tests in air atmosphere

2) Creep rupture tests in helium

3) Creep rupture tests in H_2 + CO gas

4) High temperature corrosion experiment (in He atmosphere, in steam)

5) Hydrogen permeation tests

6) High temperature tensile tests in different atmospheres

7) Carburization tests

8) Test measurements on heat transfer rate and thermal expansion coefficient

Creep Rupture Tests in Atmosphere

When metallic metals are used at high temperature, forces so small that they would be of no concern at low temperature can cause deformation over the course of time. This behavior is called creep, and the phenomenon in which this creep causes material failure is called creep rupture. The intermediate heat exchanger material which has been alluded to all this time is subjected to 40 atmospheres internal pressure (since 45 atm is applied from the outside, it is the case that this material is actually not exposed to 40 atmospheres pressure) at 1,000°C. At the same time, this material is also subjected to thermal stresses at the time of starting and stopping as well as those exerted by the weight of the pipes themselves. Should a weak alloy be used, creep deformation sets in on long term usage to eventually result in rupture and thereby become a potential source of a major accident. The most important property of a heat resistant alloy used in a heat exchanger is small creep deformation under a fixed set of conditions. At the same time, any creep fracture must require very long time. The first objective of the first stage plan of this project was the development of a heat resistant alloy capable of more than 50,000 hours of continuous operation, and this alloy was expected to be capable of more than 10,000 hours continuous operation when scaled up to industrial size. The material had to satisfy creep rupture tests at least up to 30,000 hours or more if such long term life were to be assured. This is why the creep rupture tests conducted at the National Research Institute for Metals were centered on tests at 1,000°C for up to 5,000 hours, at 1,000°C for 10,000 hours, and at 1,000°C for 30,000 hours. In addition, there were accelerated tests at 1,050°C, and tests at 900°C for materials used in systems other than the intermediate heat exchanger (steam reformer, reducing gas heater, etc.).

The results of these creep rupture experiments made possible the selection of an alloy from the list of the candidates proposed in 1973, and alloys based on the former Ni-base heat resistant alloys but with the best creep rupture strength and properties considerably better than those of Inconel 617 alloy were obtained, and these alloys are presently undergoing verification tests. The fact that such superior heat resistant material was obtained is a very pleasant experience for this country which has relied in the past mainly on imported technology with very little thought of self development, and the heat resistant alloy industry of Japan received a major boost. This is an item believed to merit very high marks.

Now, the alloys proposed in JFY 1973 included many incorporating CO to enhance high temperature strength, and layers or whiskers form on the surface of the tubes from long term use at high temperature. Should this scale off and get into a reactor, harmful radioactive material could be produced and there is the possibility of creating a hazardous situation. Therefore, proposals for new alloys not incorporating CO were received in 1975, and these are being tested presently at the National Research Institute for Metals. Alloys which are not inferior but superior to those proposed in 1973 are found on this new list.

Experiments in Helium Atmosphere

Tests in the atmosphere have been described to this point, but the high temperature heat exchanger is intended to be used in an atmosphere that is the helium coming out of a high temperature gas cooled reactor. Helium is a typical inert gas, and this atmosphere does not cause oxidations and reductions. At the same time, there is essentially no corrosion of the heat exchanger material resulting from this helium. Now this helium circulates around the nuclear reactor as a result of which it usually contains impurities in the form of H_2, CO, CO_2, CH_4, H_2O, and such. At the present time, Japan has had no experience in operating a high temperature gas reactor so that an exact decision cannot be made, but impurity levels of 300 ppm H_2, 100 ppm CO, 1 ppm CO_2, 4 ppm CH_4, and 3 ppm H_2O are anticipated. These trace impurities interact with the heat resistant alloys at high temperature giving rise to carbon extraction and grain boundary corrosion, and it is said that the aforementioned creep behavior involves phases considerably different from those seen under atmospheric conditions. With this background, the National Research Institute for Metals established a helium atmosphere creep rupture test facility at its Tsukuba Branch Laboratory where creep rupture tests are being conducted at 1,000°C, 1,050°C, and

900°C while helium with the concentrations of impurities given above is circulated. This type of tests requires not only complex test facilities but maintaining constant impurity levels, making them very difficult to conduct. At the present time, data for about 10,000 hours are available.

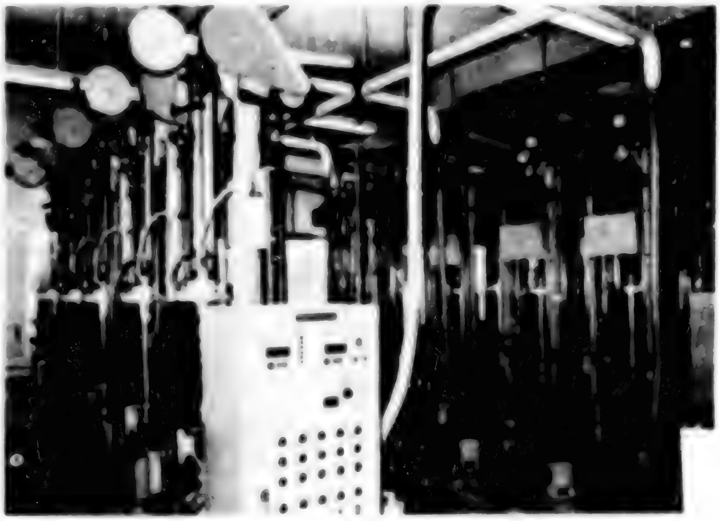
In addition, the helium gas coming from an actual high temperature gas reactor does not always approximate the composition that was given above, and high temperature corrosion tests are underway in which five different gas compositions will be used.

Experiments in Atmospheres Such as Reducing Gas

The metallic materials used to fabricate the facility to produce reducing gas to reduce iron ore and the heat exchanger to heat reducing gas to 850°C with the 950°C helium gas coming from the intermediate heat exchanger are required to possess high creep strength and superior corrosion resistance in a reducing gas consisting primarily of H_2, CO, and CO_2. Should H_2 which is one of the principal components of this reducing gas permeate the side wall of the heat exchange pipes and mix in with the helium and then be introduced in the reactor, the core will suffer severe damage. As a result, the hydrogen permeability of the heat resistant alloy also becomes one of the items of evaluation for the heat resistant alloy. In addition, some thought also needs to be directed at corrosion of the alloy when exposed to high temperature high pressure stream.

The National Research Institute for Metals is in charge of these experiments. Since it is necessary to handle H_2 gas which is explosive, CO gas that is not only explosive but also toxic, and high temperature high pressure steam, a facility that takes into account safety factors against any trouble from such sources has to be designed and a thoroughgoing control system has to be set up for the experiments. These experiments are being conducted taking all these safety measures into account.

Photograph 1. Helium Atmosphere Creep Rupture Test Facility



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STATUS OF CONTRACT RESEARCH AND DEVELOPMENT

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 29-32

[Article by Keiji Shimokawa, Atomic Energy Steelmaking Technology Research Association]

[Text] The Atomic Energy Steelmaking Technology Research Association created in May 1973 signed a contract with the Agency of Industrial Science and Technology and has been conducting research and development. The first stage was intended for the development of the principal constitutive elements of the nuclear power steelmaking process, and JFY 1979 will be the last year for this first stage. The research conducted over the past 6 years have attained a status such that the targets established by the Agency of Industrial Science and Technology seem achievable.

Progress Status of Research and Development

1) High Temperature Heat Exchanger

The high temperature gas reactor is claimed to be a clean nuclear reactor from which there is extremely small discharge of radioactive materials. This large project proposes a further enhancement of system safety through the installation of an intermediate heat exchanger which extracts the heat from the primary helium coming out of the nuclear reactor and transfer this heat to secondary helium which is then used for process heat in the system that has been adopted. It was necessary to establish completely new design standards for this heat exchanger in order to be able to handle heat transfer at temperatures close to 1,000°C. In addition, much basic research was required for design and fabrication. The results of such researches were the basis for the design and fabrication of helical coil intermediate heat exchangers with 1.5 MW heat exchange capacity and high temperature helium test loops. Roughly 4.3 billion yen was spent before these were completed in June 1978. The building housing the test loops is shown in Photo 1. The operations are taking place in fairly good order, and performance records of 2,051 hours of helium circulation operation, 800 hours high temperature operation at 900°C or higher, and 406 hours rated-load operation at 1,000°C have been compiled.

2) Super Heat Resistant Alloys

It is said that the heat transfer material used in the intermediate heat exchanger must have creep rupture strength of at least 1 kg/mm^2 for 50,000 hours at 1,000°C. Since no material on hand possessed such property, the development of this heat resistant alloy became an important theme, and development was initiated on a super high temperature resistant piping material of 5 mm wall thickness, 25 mm external diameter, and at least 7 meters length. There have been 11 proposals for such alloys since the inception of this program, and properties tests are being conducted on five such materials at the present time. Tests such as creep rupture tests in different atmospheres, corrosion tests, hydrogen permeation test, heat transfer rate measurements, and linear thermal expansion coefficient measurements are under way at the National Research Institute for Metals.

3) High Temperature Thermal Insulating Materials

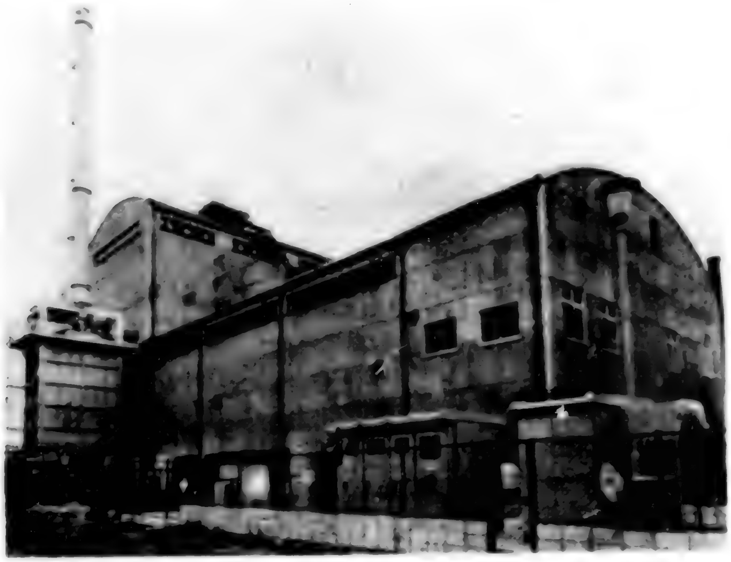
This involves the development of insulating material that will retain insulating properties over long duration and in stable manner in a high temperature helium environment. Quartz glass fiber type insulator and alumina-silica type fiber type insulator are the subjects of this developmental effort, and research on method of manufacture and tests on material properties is under way.

Material development is directed mainly at repressing the devitrification behavior and minimizing the contraction rate of quartz glass fiber and to improving the recovery rate of alumina-silica family material. As far as devitrification is concerned, this behavior has not been observed as yet. The very extreme contraction rate of less than 0.1 percent after 50,000 hours at 1,000°C has been stipulated, and it was possible to meet this condition through the proper selection of starting material, appropriate sintering temperature, and adequate sintering time. A recovery rate of more than 20 percent is the targeted value after 50,000 hours at 1,000°C. Tests using temperature gradients have given some favorable results.

Research on methods of producing thermally insulating structures combining quartz glass fiber with alumina-silica fiber and tests on the thermal insulating properties of these structures are being conducted.

4) Reducing Gas Production Facility

After reduced pressure residual oil has been decomposed with high temperature steam, the light hydrocarbons go to a steam reformer while the pitch goes to a gasification facility which consists of two fluidized layers where the pitch is converted to reducing gas, and low sulfur fuel oil is produced at the same time. Development of a heat exchange steam reformer using high temperature helium and pitch gasification facility is being promoted in this project. All these developments were preceded by basic research. In the case of the former, a test plant to process naphtha at the rate of 100 kg/h was completed at the end of May 1978 while a test plant for treating pitch at the rate of 200 kg/h was completed at the end of September 1978, and both plants are now operating. The steam reformer logged 2,700 hours operation by the end of June 1979 while the pitch gasification facility has racked up 1,500 hours operation, and important information on facility development has been obtained. The steam reformer test plant is shown in Photo 2.

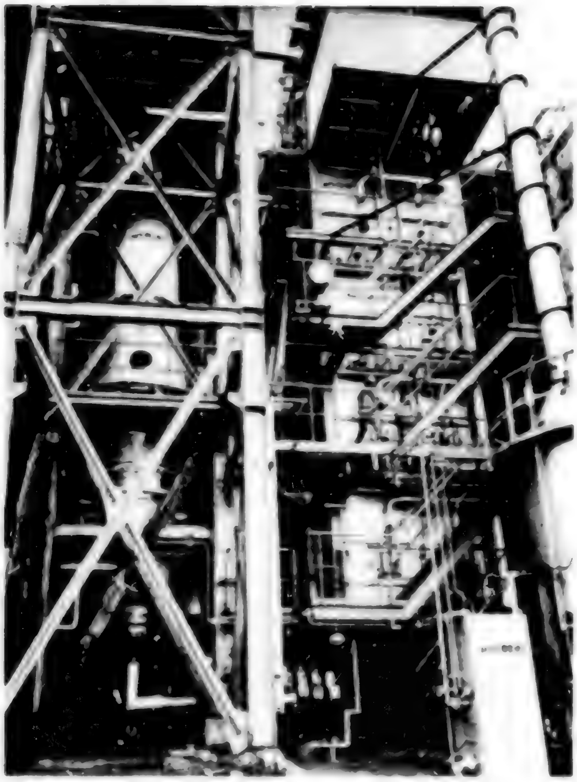


Photograph 1. High Temperature Helium Test Loop Building

5) Reduced Iron Production Facility

The development of a high pressure shaft furnace was required from the standpoint of compatability with the nuclear power steelmaking system. Research was conducted on the reduction reaction under high pressure and equipment of the shaft furnace.

A shaft furnace simulator was constructed for the specific purpose of studying this problem, and detailed research in the high pressure reduction reaction of iron ore was conducted to select optimum reducing gas composition and pressure. In addition, data necessary to the design of high temperature shaft furnaces were compiled. At the same time, research on charging and discharging devices was conducted using a cold model, and these results combined with the research results on gas flow within the shaft furnace led to the completion of the conceptual design of a 2,000 T/day high pressure shaft furnace.



Photograph 2. Steam Reformer Test Plant

6) Total System

We have dubbed the nuclear power steelmaking system to be coupled to the 50 MWt high temperature gas reactor planned for construction at the Japan Atomic Research Institute the FM 50. Research on the total system is aimed at coming forth with the conceptual design of this FM 50 system. The basic plan involves the result of studies which have been compiled in Figure 1. Primary helium entering the intermediate heat exchanger comes in at 990°C and 40 atm pressure while the secondary helium leaving this heat exchanger is at 925°C and 45 atm. There is a steam heater, steam reformer, and reducing gas heater deployed in parallel array to the high temperature side of this secondary helium loop while a steam generator is installed to the low temperature side. Steam heated to 850°C at the steam heater is utilized in the decomposition of reduced pressure residual oil and gasification of pitch. Gas from the steam reformer and the reducing gas from the pitch gasifier pass through the shift converter where it is temporarily cooled to enable compositional adjustment after which they are once more heated to 850°C at the reducing gas heater and fed into the shaft furnace. The gas exiting from the top of this shaft furnace is for the most part circulated in the closed system that has been adopted. Conceptual design of this FM 50 system including system makeup, heat and material balances utility design, plant layout, basic operating design, basic control design, and basic plan for the instrumentation system is underway.

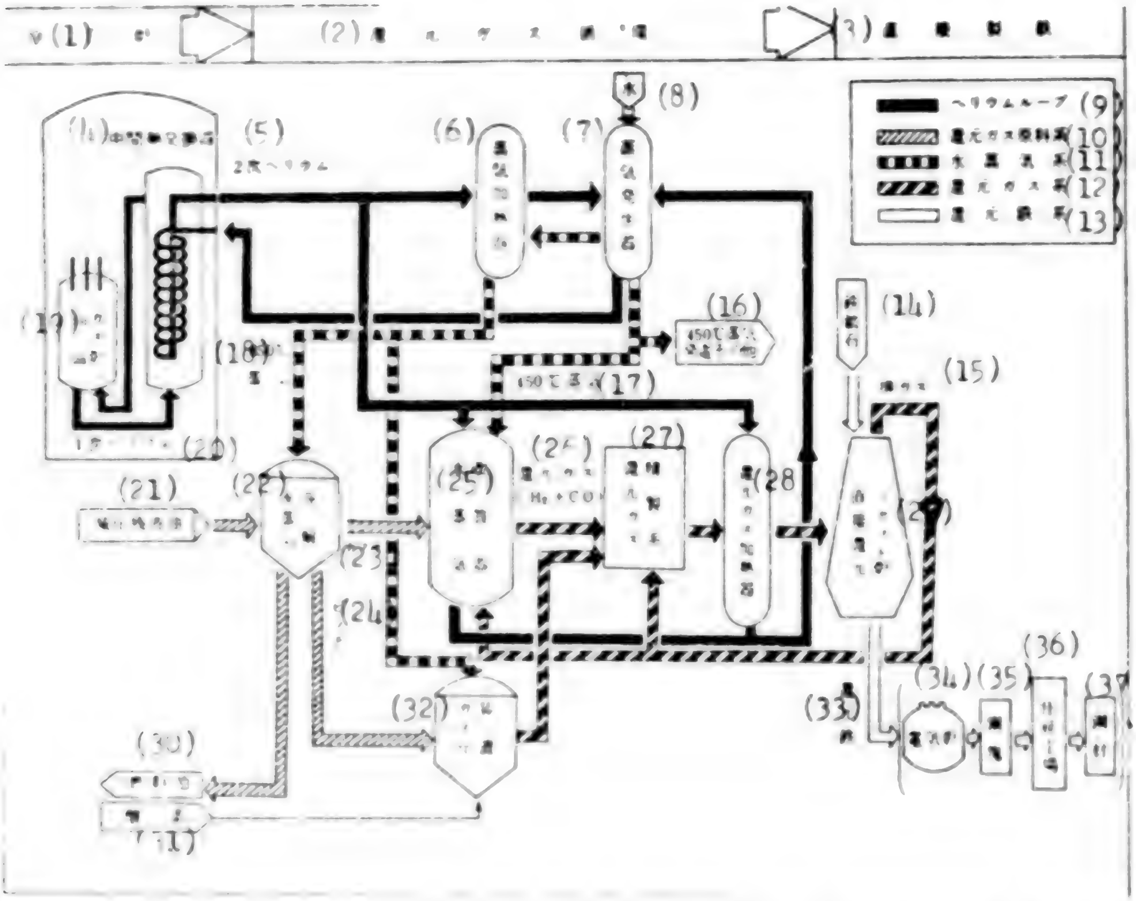


Figure 1. Conceptual Design of Nuclear Steelmaking System

(1) nuclear reactor
(2) reducing gas circulation
(3) direct steelmaking
(4) intermediate heat exchanger
(5) secondary helium
(6) steam heater
(7) steam generator
(8) water
(9) helium loop
(10) raw materials for reducing gas
(11) steam system
(12) reducing gas system
(13) reduced iron system
(14) iron ore
(15) exhaust gas
(16) power generation with 450°C steam and other uses
(17) 450°C steam
(18) 850°C steam
(19) high temperature gas reactor
(20) primary helium
(21) reduced pressure residual oil
(22) steam decomposition
(23) naphtha
(24) pitch
(25) steam reformer
(26) reducing gas (H_2 + CO)
(27) reducing gas purification system
(28) reducing gas heater
(29) direct steelmaking shaft furnace

[key continued on following page]

[Key to Figure 1 continued from preceding page]

(30) fuel oil	(34) electric furnace
(31) oxygen	(35) steel ingots
(32) gasification facility	(36) rolling mill
(33) reduced iron	(37) steel

Situation in Foreign Countries

1) United States

The United States Steel Association set up a task force to investigate the technological and economic possibilities of nuclear power steelmaking in 1973. This task force discovered a number of reasons why the technological development of nuclear steelmaking should be followed, and an appeal was made to the government to provide developmental funds. However, there was no followup except for the selection tests on heat resistant materials. Recently, however, there has been renewed efforts to reassess the utilization of process heat from high temperature gas reactors, and there is a movement to form a users group including steelmakers, gas suppliers, and chemical industry members.

2) European Nuclear Energy Steelmaking Club (ENSEC)

The steelmaking industries of seven European countries formed the nucleus of ENSEC in September 1973. Research was promoted through four working groups, but they all terminated their programs after the compilation of reports. There is no evidence of ENSEC activities at the present time.

3) West Germany

With active assistance from the government, the developmental project "PNP" plan to utilize heat from a high temperature gas reactor in the gasification of coal was initiated centered on the Julich Nuclear Laboratory where joint research on the part of five companies is underway. Research on water-additive gasification of lignite and steam decomposition of bituminous coal for gasification is underway presently and test plants of 200 kg/h each are being operated as the prime activities. Development of a 500 MW high temperature gas reactor for process heat is progressing according to schedule. This project is not specially directed at nuclear power steelmaking but it designed more to use nuclear process heat to gasify lignite and coal for wide industrial use and for civilian needs.

Concluding Statements

This large project has taken up 13.2 billion yen during 7 years and engages the efforts of more than 500 researchers and technologists. The initial plans have been followed closely, and development of technology in compliance with various demands has been promoted while all-out efforts are being directed at completing the first stage. The second stage will involve actual development of the nuclear power steelmaking "system," and it is expected that research and development will be continued with particular emphasis on demonstrating safety.

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AUTOMOTIVE COMPREHENSIVE CONTROL TECHNOLOGY

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 33-36

[Article by Masakuni Yamazaki, Office of the R and D Officer, AIST]

[Text] Need for Development

Highway traffic in large cities is associated with serious social problems such as pollution, accidents, and congestion brought about by the increase in number of automobiles. The peak traffic fatality of 16,765 experienced in 1970 has been successfully lowered to 8,945 in 1977 as the result of traffic safety policies, but the number of automobiles and the number of licensed drivers are increasing by the year (there were 35 million automobiles and 38,990,000 licensed drivers at the end of 1978) as a result of which atmospheric pollution and traffic congestion remain as chronic conditions. There is great need for the development of policies to remedy this present situation. This project was started in 1973 scheduled for 7 years, and it is directed mainly at "the control of automobile traffic in an overall manner." It will engage computer technology to pursue its intended goal of developing an information system for automobile traffic exploiting the latest technology.

Outline of Technology

The systems presently used in traffic control are for the most part wide area signal control systems. This type of system measures traffic flow for an entire region and controls the stop-go patterns of various signal lights through centralized control in order to alleviate traffic congestion. This type of system is used in 40 major cities of Japan. In contrast, the present project envisions a system that will make possible overall comprehensive traffic control through five subsystems (route guidance, running information, emergency reports, variable situation board, and public vehicle priority subsystems) in which the route guidance subsystem is the main member. The capability of this route guidance subsystem involves the driver entering a code designating his destination at the time he gets into his automobile whereupon there is a display within his vehicle of the traffic situations at the major intersections before he comes to them to show whether the situation is favorable for left or right turn or direct continuation of his direction of travel so that the driver can avoid areas of congestion and get to his destination in the minimum time. This subsystem further has the capability of more appropriate distribution of traffic over an entire area making possible easing of congestions and reduction in overall driving time.

The other subsystems are described briefly below.

The running information subsystem is designed to prevent accidents by transmitting and displaying within a vehicle traffic restraints such as temporary stoppage or speed restrictions and sounding an alarm when the posted speed is exceeded by the vehicle.

The emergency information subsystem broadcasts local information on emergencies such as incidents of disasters or atmospheric pollution through roadside facilities which are received over the car radio. It can provide traffic information when things are normal.

The variable information board subsystem is designed to provide the capabilities of the above mentioned route guidance subsystem to automobiles not equipped with that capability. It displays a small network of the routes upon which are displayed the congestion situation, and the driver then is able to select his route.

The public vehicle priority subsystem detects the routes of ambulance and route bus emergency and public vehicles and effects signal controls to give these vehicles priority in going through intersections.

Point of Research and Development

The most important point of this research and development is the development of a system to be introduced into actual cities as a social system which is to be realized through an optimum total system when seen from the social, economic, and technological viewpoints. At the same time, there is need to develop the best suited software, ground equipment, and vehicle based equipment to enable effective implementation of this system, and these three points make up the essence of the objective of this program.

1) Research will be conducted on an algorithm to enable optimum control of traffic which varies with time through a system that will be effective in resolving the various problems associated with urban traffic using system design that is economical and is technologically feasible and operable.

2) Establish communication technology such as electromagnetic induction and millimeter wave communication which is a coupling of two-way communication between a moving automobile and a roadside unit, which overcomes urban noise and various radio interferences to enable communication in very short

time, and which is a reliable information exchange technology. At the same time, develop a roadside unit which possesses high reliability to operate under the harsh environmental conditions and with many capabilities packed into a small volume.

3) Develop vehicle-borne equipment which takes into account the physiological and mental elements of the driver during vehicle operation which is associated with superior information submission mode from the standpoint of human engineering and which has high reliability, is low in cost, is small, and is light.

Synopsis of Research and Development Results

When this project was started in JFY 1973, basic research and basic test production were conducted along the lines of 1) system design and traffic control mode, 2) communication mode, roadside equipment, 3) vehicle equipment. Development of software for the traffic control mode test construction of system equipment for evaluation purpose, and execution of "small scale experiments" within a plant were undertaken during JFY 1974, and it was established that these software and hardware attained their target performance. These results were the basis for the production of software and hardware to assembly a pilot system that took up the efforts during 1975, 1976, and the first half of 1977. The equipping of the experimental area was completed, coupling tests of constitutive elements, and basic system tests for establishing overall performance were completed, and the pilot system was completed.

The pilot system was one in which the participants were the National Police Agency, Ministry of Construction, and the various prefectures all of which are government offices with an interest in the traffic problem. The vehicle equipment was designed with the drivers in mind who were ordinary citizens, making this a social system. In addition, this system is one which was tested on an actual urban scale in actual traffic flow in order to demonstrate its ability to control the actual complexities of urban traffic. Comprehensive experiments were conducted for a year starting in December 1977 from which experimental data were accumulated, normal operation was maintained, and operational research to rectify interference was conducted (the experimental contents will be discussed below).

From the many results on element technology making up this pilot system, the following are cited as some of the major results of this research and development.

1. Roadside Computer for Route Guidance

Computers have been used in the past in a protected environment such as an airconditioned area. The roadside route guidance unit of this system has the capabilities of a central processor, main memory, read only memory, and interrupt control device with a memory of 8K words and 16 channels. Because it is installed on the roadside, it must withstand severe environmental conditions such as wind and rain, lightening, high and low temperatures, vibrations, and radio noises. About 100 computers were test produced which were each encased in a 150 liter or 100 liter containers, opening up a new role for computers.

2. Two-Way Communication System with a Moving Body

A roadside unit to vehicle communication system was completed in which two-way communication between a roadside unit and an automobile traveling at 100 km/hr was achieved through a 162-bit digital information exchange with communication error less than 10^{-4} through the use of very weak radio waves and loop and ferrite coil antenna which represented a great improvement over the one-way voice (analog) guidance system of the past.

3. Vehicle Unit for Route Guidance

The vehicle-based unit mentioned in the preceding paragraph consisting of communication section, information processing section, and display section was miniaturized and made over into a low power consuming unit through the use of LSI and provided with capability of withstanding environmental effects. In this manner the world of information available to an automobile which in the past was restricted to the radio was greatly expanded.

4. Traffic Prediction Algorithm

A numerical model which predicts 15 minutes and 30 minutes in advance the time required to cross certain intersections within a running network using actually measured values in experimental vehicles was developed, and this unit makes up the core of the control capability of this project.

5. Minimum Time Route Search Hardward Simulator

The volume of computations for determining the optimum route within a highway network is astronomical, but the development of a simulator which has a LSI core and simulates network makeup and traffic flow situation has succeeded in great reduction in the required computational time and miniaturization of the unit.

6. Millimeter Wave Communication System

The 60 GHz milliwave band close to the radio wave border is associated with strong oxygen absorption, making broadcasting out of the question. Despite this shortcoming, it can be used for communications between a roadside unit and a running vehicle in which about 1 million bits can be transmitted in 30 milliseconds. This large volume of information can be given in the form of graphic display or voice message, and wide applications are anticipated.

7. Emergency Information System

This is a system for voice of broadcasting emergency or normal traffic information with a range of about 400 m on the highway. It is made up of an automatic compiler central facility, leak coaxial cable antenna on the roadside transmitter, and adapter for car radio connection. The first type of emergency information is on major incidents such as disasters, while the usual second type information is on congestion information or detour information. The first type information is broadcast regardless of the driver's volition while the second type is information which a driver can select at will. At the same time, it is provided with a direction valve discrimination capability to provide separate information to traffic going in opposite directions.

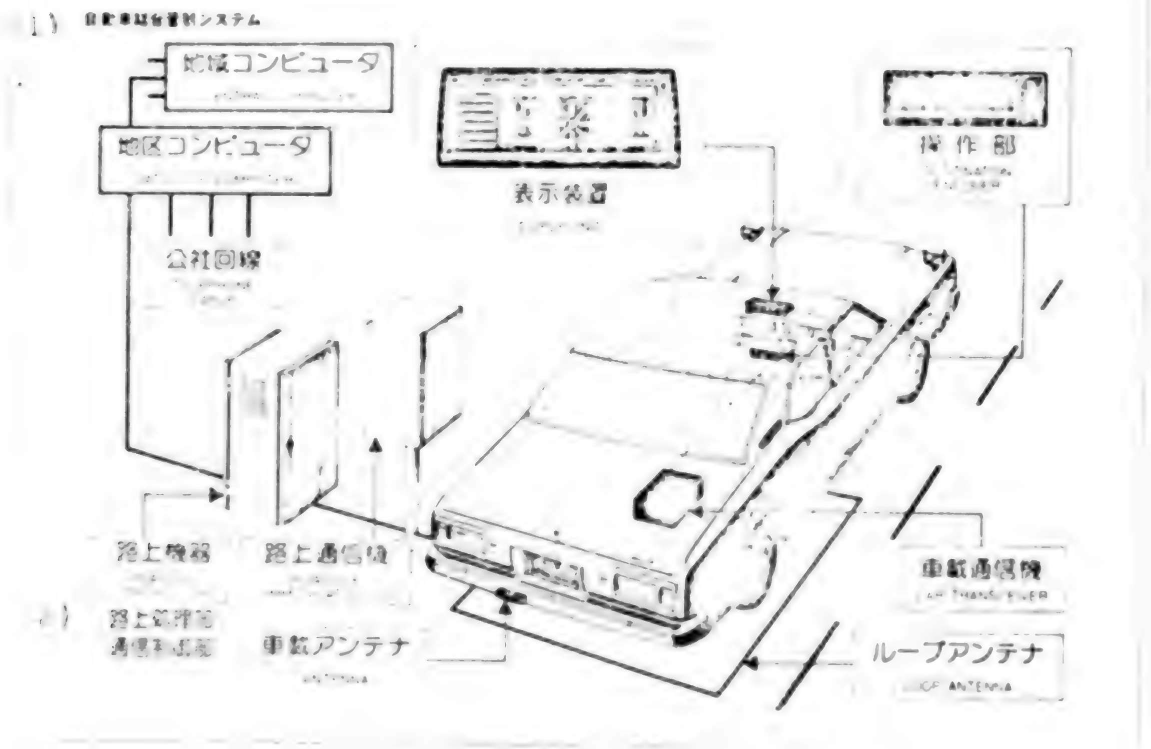

Figure 1. Make-up of Route Guidance Subsystem

Key: (1) comprehensive automobile control system
(2) roadside processing section, communication control section

8. Contents and Results of Pilot System Experiment

The pilot system experiment was conducted as a five subsystem study covering a 30 km^2 area of the southwestern district of Tokyo centered on Meguro-ku (about 100 km of roads) in which 121 roadside units and 1,330 automobiles were used. The installations used in this experiment include an experimental center with computer and control desk, data transmission circuit to tie the center to the roadside units, roadside units installed along the highways, antenna to enable communication between automobile and roadside unit and automobile based unit to transmit destination code and direction of driving display. This was the 5-group division, and the makeup of this pilot system is shown in Table 1. The results of this experiment are given in a separate report so only a part will be presented here.

Table 1. Makeup of Pilot System

Item	contents, scale
district	southwest section of Tokyo
area of district	about 30 km^2
number of guided intersections	70 (general), 15 (main city intersections)
number of roadside units	
for route guidance	103
for running information	5 (on line), 10 (off-line)
for emergency use	9
for variable information board	3
for millimeter wave communication	1
number of transmission antenna facilities	
loops	255 sites (582 lanes)
ferrite coil	20 sites (36 lanes)
leak coaxial cable	9 points (about 400 m)
horn (for millimeter wave use)	one site (2 lanes)
number of equipped vehicles	
for route guidance	330 units
for running information	
for information collection	1,000 units
for emergency information	30 units

[Table 1 Continued]

Item	contents, scale
for millimeter wave use	2 units
total number of vehicles	1,330 units
vehicle receivers	179
experimental center	
electronic computer system	NEAC 2200-375 1
	NEAC 3200-70 4
	HIDIC-350 1
	one minicomputer
control room	wall type display model 1
	CRT 6

Summarizing the results of the guidance subsystem test, a comparison of the situation at the final stage of this comprehensive test showed the vehicles with route guidance with 135 net gain and 26 net loss in driving time saved compared to vehicles without this guidance, and an average reduction of 11 percent driving time was realized. It was thereby demonstrated that this system can adequately contribute to improving city driving conditions.

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EQUIPMENT ENVIRONMENT TOLERANCE TESTS

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 36-37

[Article by Sadayuki Tsugawa, Mechanical Engineering Lab, AIST]

[Text] Introduction

Research and development on equipment whose objectives had been established from the results of pilot experiments was initiated in the area of comprehensive automobile control technology. These equipment are required to possess a high level of information processing and transmission capability and must function as electronic equipment under very adverse environment whether installed at the roadside or in automobiles to provide complete operation as elements of the system they belong to. Surveys of the environment at roadsides and within automobiles were conducted, and the results were used by the Mechanical Engineering Laboratory to set up conditions for environmental tests on roadsides and inside automobiles and methods of performance tests, and environmental tolerance tests were conducted on various equipment test produced during JFY 1974. These test results were then used to set up even more rigorous environment tolerance test conditions in JFY 1975, and equipment developed from JFY 1975 through 1977 was tested.

Environment Tolerance Test Conditions

The environment tolerance test conditions consist of the provisional set drawn up in JFY 1974 and the final set drawn up in JFY 1975. The environment tolerance tests of JFY 1974 placed their emphasis primarily on accumulating data relative to the behavior of the equipment with respect to the environment rather than on the tests themselves. As a result of the tests conducted during JFY 1974, the problem areas of the equipment were clarified, and there was marked improvement in equipment design technology on the part of the companies responsible for their production. These results were then incorporated into the environment tolerance test conditions that were established in JFY 1975. The final set drawn up in JFY 1975 are described here.

Vibration Tolerance Test Conditions

1) Vibration Conditions

1) Compound vibration amplitude: 2 meters

2) Vibration frequency: 5-20 Hz

3) Period of vibrational changes: about 3 minutes

4) Direction of vibrations: up-down, left-right, forward-backward

5) Vibration duration: 30 minutes in each direction

2) Performance test

1) Where vehicle based equipment is concerned, performance tests are conducted while the vehicle is in vibration, and a DC 12 V power source will be used.

2) Where the roadside equipment is concerned, a single test in each direction is conducted before and after vibration, and a 100 V AC source will be used in this case. No current is passed during vibration.

2. Temperature and Humidity Test Conditions

1) Temperature and humidity conditions

1) The high temperature will be + 60°C and the high humidity 90 percent while the low temperature will be -20°C and humidity as is. The tests are conducted for 3 hours each.

2) Performance tests

1) Performance tests will be conducted in continuous manner from initiation to termination of tests for both vehicle based and roadside equipment.

2) The voltage applied on the test body will be 11 V DC for low temperature and transition period to low temperature tests, 80 V AC for roadside equipment, 16 V DC for vehicle equipment during transition to high temperature and at high temperature, and 110 V AC for roadside equipment during transition to high temperature and at high temperature.

3. Anti-Rain Test Conditions

1) Rain conditions

1) Volume of rain: about 900 mm/h or more

2) Direction of rain: sweep from vertical direction to 60°C from the vertical

3) Period for change in direction of rain: 1 minute

4) Duration of rain: 1 hour

5) The orientation of the test body will be changed 90° every 30 minutes after initiation of rain

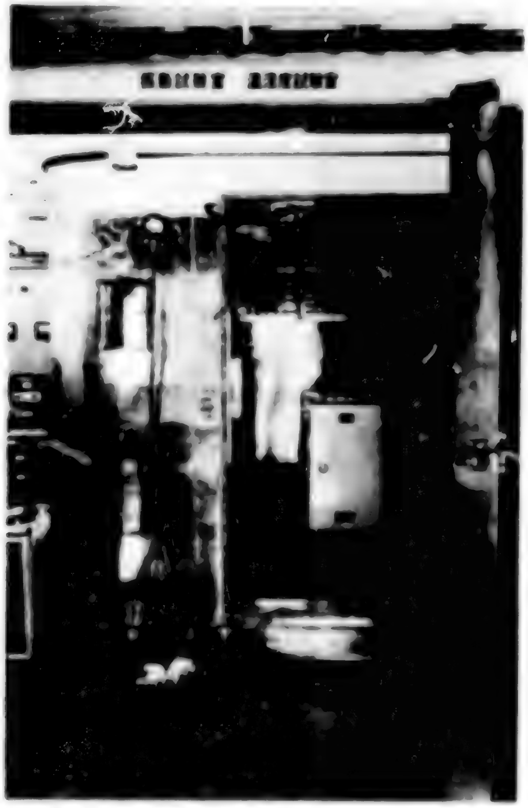
2) Performance Tests

The anti-rain test is applied only to the roadside units, and the performance test is conducted after 2 hours of continuous rain. The voltage source is a 100 V AC source.

Environment Tolerance Test System

The environment tolerance test system is comprised of the environment forming facility and the performance testing facility. The environment forming facility incorporates the three devices of vibration resistance test unit, temperature and humidity test unit, and anti-rain test unit. These units are capable of providing adequate environment resistance test conditions that were described before. A roadside unit installed within this environment simulation facility is shown in Photo 1.

Photo 1. Roadside Unit Within Temperature and Humidity Test Chamber



The performance testing facility has as its nucleus a high reliability control computer and includes a number of interfaces. When the performance of a roadside unit is being tested, an on-line performance test at high speed using an electronic computer is performed in which the control center computer and several units (6 units) of vehicle borne units are simulated while the roadside units and drivers are simulated in the vehicle borne equipment performance tests. Software developed at the Mechanical Engineering Laboratory has enabled complete automation of the continuous performance required over long period, and worst case data are used to effectively test all the capabilities of the unit.

Summary

Between JFY 1974 and 1977 more than 25 different types of roadside and vehicle units and more than 200 pieces of equipment were subjected to environment tolerance tests, and it was demonstrated that all the pieces of equipment developed since JFY 1975 passed the tests. These pieces of equipment then were used in the pilot experiment area and in pilot experiments starting in the fall of 1977. Pilot tests extending over a year showed these equipment to display very favorable operating behavior, and the pilot tests were successfully concluded. These results demonstrated the adequacy of the environment resistance test condition and the performance testing method.

In another direction, development of automobile traffic flow instrumentation was conducted independently of the environment tolerance testing of equipment by the photoelectric conversion element group. This facility measures the spacewise speed distribution of automobile traffic flow, and research is being conducted with the objective of correcting the information provided by the loop type or supersonic wave type automobile traffic flow detector. The operation is based on the principle in which the speed of the automobile is calculated from the transition time of an optical image of said automobile across a pair of microscopic photo-electric conversion elements. This facility was developed in JFY 1977 and was installed on top of a Tokyo building along Keihin National Highway No 1. It has operated in favorable manner for more than a year and it has continued to record average speed data on traffic flow at six sites (at 50 m intervals) on the national highway.

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PILOT SYSTEM CONSTRUCTION AND TESTS

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 38-39

[Article by Haruna Nakai, Managing Director, Automobile Comprehensive Control Technology Research Association]

[Text] Introduction

Highway traffic in large cities is presently become an important social problem in ever increasing degree, and it has become mandatory that rather than simple reversion to technological developments, experimental efforts at studying the effectiveness of comprehensive social systems in large cities be made, results of these experiments be used to introduce the technology to society, a wide range of general viewpoints be collected, and latent problems which will encountered during future practical application be clarified. Following this line of thought, experiments in actual cities through the use of pilot systems were incorporated into the plan of this project.

Establishment of the Pilot Experiment System

The four areas of Shibuya, Edo, Shinjuku, and Ginza were considered as candidates for this experiment at the outset. As the result of comparative studies on the number of alternate routes, possibility of selecting routes in line with the traffic situation, ease of construction, and PR effect, the Shibuya district was selected.

The first activity of the research association was an on-site survey of the basic layout construction of the roadside equipment facility. The situations with respect to the equipment facility, presence of installation space, roadway conditions, exclusive use of the highway, permission for use and construction pillars, aerial wires, and people-related faculties were studied in detail after which the selection of likely sites for project construction was made. The basic facility layout of each roadside facility was derived based on this on-site survey data, detailed plans were made, and project permit procurement activity was initiated. There were 59 organs from which permits had to be acquired, and we received the utmost understanding and cooperation from the concerned officials, but there was formidable opposition from local residents and considerable concern resulted.

Much of the roadside construction was performed on holidays and at night when it was possible to minimize obstruction to traffic flow. At the same time, the method of construction was successively modified in a manner designed to reduce traffic obstruction to a minimum. At the control center, software development people worked day and night to debug the system and to engage in a number of activities in preparation for the experiment. In addition, demonstration tests were conducted to see how sole-use roadways could be incorporated and the system overall could be operated in adequate manner. There was also the selection of more than 1,000 information collecting vehicles and 300 automobiles cooperating in the experiment along with 30 experimental vehicles, and the equipping of these vehicles with the necessary gear was conducted. The pilot experiment system was completed in December 1977 through the activities described above, and the experiment was started.

Pilot Experiment Test Experiment

The following were the three objectives of this experiment.

1) To demonstrate whether the newly developed technology is effective in the environment of an actual city.

2) To collect data relevant to latent problems that may arise when the system is put into practical use in actual traffic in the future.

3) To publicize the results of this research and development to the general public and survey public opinion with regard to these results.

The experiment was conducted over a year's span from October 1977 to the end of September 1978.

The experiment was conducted on all five subsystems, but the route guidance subsystem was the item of major concern from the standpoint of comprehensive automobile control technology. The recognition that this capability can be adequately exploited in the environment of actual traffic flow was one of the major objectives of this experiment. This involved the processing of travel time information on actual traffic flow obtained by the route guidance subsystem by the computer group at the control center and supplying information necessary to the subsystem such as emergency and variable information.

At the same time, this project solicited monitors from the general public in addition to the vehicles from member companies of the association and government offices in line with the viewpoint of "development of a social system." These vehicles were provided with the necessary vehicle borne equipment and were always operated in normal manner throughout the course of the experiment in their participation in this experiment.

In addition, these vehicles were enlisted for participation in special experiments at designated times one day of each month, and questionnaires and interviews were used to collect opinions regarding the performance of the various subsystems and the man-machine interfaces.

During the first half of the experiment the route guidance subsystem was operated in the manner of traffic flow predictions centered on information obtained from information collecting vehicles (1,000 taxis) which was then passed on to the experimental automobiles, but the paucity of information coupled with the biased routes taken by these taxis resulted in performance which was not always favorable. As a result, greater attention was given to the deployment of these experimental vehicles during the latter half experiment, and it was demonstrated that the targeted objectives were realized.

Outline of Experimental Results

The environment tolerance of the various subsystems' roadside equipment headed by the route guidance subsystem equipment was all satisfactory despite the fact that they were pieces of equipment. When the practical stage is approached, the actual results obtained on roadside equipment of the traffic control facilities will be referenced to pursue development of even more miniaturized, low power consuming, and economical and readily maintained units.

The central equipment in the control center was an experimental facility whose development was subjected to budgetary restrictions. It was associated with considerable diffuseness and was not able to provide adequate reliability, it had just been developed so that there was not sufficient time to debug under certain conditions, and the control people had not had enough time to acquaint themselves with the system making it difficult to say that the operation of the control center was always adequate. In the final analysis, however, the capabilities of the center were exploited in adequate manner.

A D-1 circuit of Nippon Telegraph and Telephone Public Corporation was used solely for tying this central facility with the terminal equipment, but there was an excessive rate of incidence of interference in the form of momentary interruptions and an occasional cutoff in digital communications. There may be a need to go to a circuit which guarantees better quality in the future or adopt some forceful communication means to eliminate momentary interruptions.

The data taken into the route guidance subsystem were successively improved, and the travel time information obtained from the vehicles for the most part were more than adequate, and these provisions in the experimental plan made possible attainment of the anticipated results in the actual urban environment.

For example, an example of the results obtained through about 1,000 test runs in 7 routes are shown in Table 1 in which reduction in travel time between 9-15 percent was realized.

Table 1. Example of Guidance Effect as Seen from Travel Time

Travel route	type of travel	average travel time	plus/minus frequencies in guided vehicles	fraction of advantageous use of route guidance	reduction rate in travel time
Uema → Tengenji	guided travel	1239	33	76.3	15.5
	free travel	1467	5		
Osaki, Hirokoji → Uema	guided travel	1327	29	72.1	9.4
	free travel	1464	5		
Roppongi → Jikisaka, Rikubashi	guided travel	1763	38	76.1	10.8
	free travel	1976	8		
Uema → Shirakane, Nichome	guided travel	1657	35	76.0	9.3
	free travel	1827	8 (1)		

Data were collected for the other subsystems through recognition of performance, questionnaire surveys, and interviews from which important material to serve as reference during the transition to the practical stage was obtained with respect to reasonableness of the contents displayed, visibility, and volume of information.

Summary

The technology developed in the manner described above was given full cooperation and support from the National Police Agency and the Ministry of Construction who are directly tied in with highway traffic and the many ministries and agencies along with all cooperating governmental offices which participated in this project development. For example, the National Police Agency and Ministry of Construction did not treat this project simply as research and development but it is said they investigated utilizing this pilot experiment system to enable docking with the control center in line with administrative needs in a move directed at practical use and to enable control of highway traffic flow through a travel time measurement network. They are said to be studying the possibility of applications in many directions.

It is said that the Ministry of International Trade and Industry is also promoting the more popular use of this technology.

The word is out that West Germany will initiate experiments on a similar system this summer partly in the form of a practical system.

It is thought that comprehensive automobile control technology holds the potential of developing widely into many directions as a comprehensive social system as a result of this trend, and it is hoped that every effort will be made to pursue smooth development through comprehensive interfaces between the various systems.

Finally we thank the Agency of Industrial Science and Technology and the related agencies and offices for their guidance and direct and indirect cooperation which made possible the execution of the construction and experimental phases of this study without the incidence of major accidents.

2267
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OLEFIN MANUFACTURING METHOD USING HEAVY OIL AS THE RAW MATERIAL

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 40-43

[Article by Yosuke Tsuji, Office of the R and D Officer, AIST]

[Text] Introduction

The method of manufacturing olefins using the low cost and abundant heavy oil as starting material is a technology to produce basic petrochemical raw materials such as ethylene, prophylene, benzene, toluene, and xylene presently being manufactured using the light oil fraction naphtha as raw material. This project plans to construct a large scale pilot plant of 120 ton/day capacity raw material, operate this plant, and complete its industrial technology in order to produce olefins by the high temperature cracking of heavy oils obtained as reduced pressure and atmospheric pressure residual oils as the final stage on the development of this technology.

The oil demand structure in Japan during the recent years has been increasing annually toward light oils such as naphtha used in the petrochemical industry as mentioned before, gasoline for automobiles, kerosene, and light oils. Fuel oil for power plants being replaced by LNG and nuclear energy has enhanced this yearly trend toward the use of the lighter oils, and this trend has been matched by import mainly of the lighter oils. Now, the future picture is such that the ratio of heavy oils in the oil supplied will increase in direct contrast to the demand for lighter oils, and it is expected that shortages will arise in the light oil area and oversupply in the heavy oil area. This is why there is an urgent need to develop a technology for the effective utilization of this heavy oil fraction.

The petrochemical industry of Japan has, up to the present time, developed the production of products such as synthetic resins mainly using the single raw material source naphtha, and the recent price increase in naphtha coupled with its insufficient volume have become problems which are rocking the foundations of this industry. As a result, the assurance of a more stable and low cost raw material has become a pressing problem.

One countermeasure to resolve the problems cited above is to develop a technology to effectively utilize the heavy oil fraction of petroleum that is presently in great overabundance as a raw material, and this is a goal of the project. This is a research subject whose completion is urgently needed in view of the recent situations including the oil situation. At the same time, it is a basically significant technology which will effectively utilize in complete manner the important oil resources for chemical raw materials.

Research and Development Situation in Other Countries

The development of olefin production technology using heavy oil including crude oil decomposition in a broad sense as raw material was once attempted in Europe along about 1960 at the time of the sudden emergence of petrochemistry. There are the Koppers method and the BASF method. There has been rapid development in the United States most recently, and the high temperature steam cracking technology has been the base for the development for the development of the ACR method (joint development by Kureha Kagaku, Chiyoda Kako Kensetsu, and UCC) that is being promoted, and it is said that a prototype for the production of ethylene from crude oil will be completed during this year. At the same time, it has been reported that a partial oxidation method of ethylene production using crude oil is under development by Dow Chemical. On the other hand, the strategy to switch to a superheavy fraction such as reduced pressure residual oil through the appropriate technology is being taken up for the first time in this project. It is thought that this technology will utilize not only crude oil but as yet underdeveloped resources such as oil sand bitumen, and interest is being shown by other countries.

Outline of Technology

The high temperature cracking technology that is being promoted through research and development on this project is called the coke heat medium circulating fluidized bed method in which the coke particles furnished within the system as a result of the decomposition of crude oil are used as the heat medium, and it uses a circulating fluidized bed decomposition facility consisting of a reaction tower and a coke heating tower. The flow scheme for the decomposition facility and its peripheral equipment is shown in Figure 1. Reduced pressure residual and atmospheric pressure residual oil which are the raw materials are preheated and then supplied to the decomposition reaction tower together with steam where contact is made with high temperature coke particles, and decomposition takes place. The temperature of this decomposition reaction is 700-800°C.

Coke particles whose temperature was lowered by supplying heat to the crude oil are sent to the coke heating tower where they are heated by the high temperature combustion gas from the combustion furnace and recycled back to the reaction tower. Byproduct decomposition residual oil (pitch) and similar materials are used as fuel for the combustion furnace.

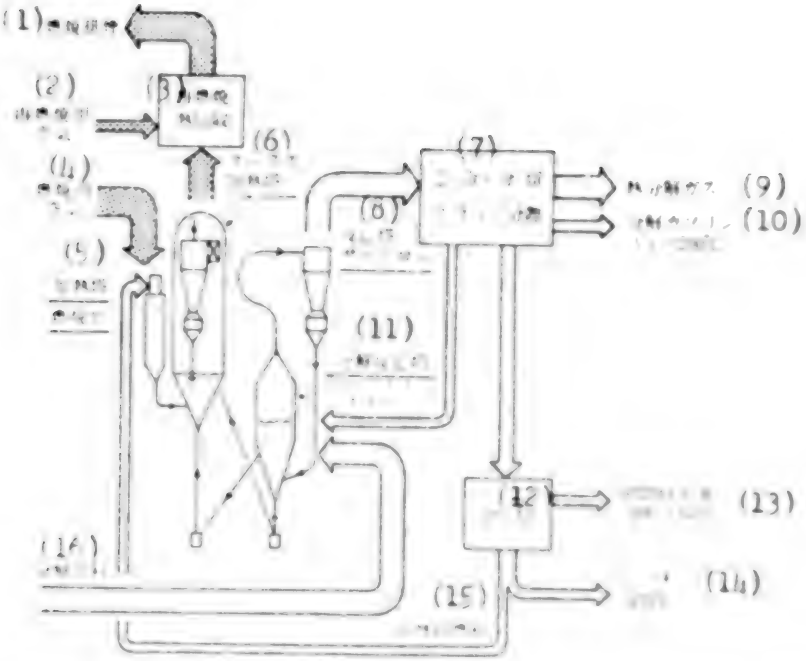

Figure 1. Flow Scheme for Heavy Oil Decomposition Using Coke Heat Medium

Key:
(1) combustion exhaust smoke
(2) air for recombustion
(3) recombustion heat recovery
(4) air for combustion
(5) heating tower, combustion furnace
(6) coke heating tower
(7) quickcooling, fractional distillation, slurry separation
(8) reaction tower cyclone
(9) thermolytic gas
(10) decomposition gasoline
(11) decomposition reaction tower coke slurry
(12) fractional distillation
(13) intermediate residual oil
(14) pitch
(15) heating tower fuel
(16) decomposition raw material

The decomposition products are separated from coke at the cyclone and quick-cooled after which they undergo fractional distillation and are separated into decomposition gas containing olefins, decomposition gasoline, intermediate distillation cuts, and pitch. The decomposition gas further undergoes an acidic gas removal step followed by purification and low temperature fractional distillation to be separated into hydrogen, methane, ethylene, propylene, and B-B cut. The pilot plant to be constructed does not include this low temperature fractional distillation process. The composition of this decomposition gas is not much different from the gas from naphtha decomposition, and the steps following the low temperature fractional distillation can be adapted to present technology almost entirely as is.

The smoke from this coke heating tower is still at high temperature and incorporates a number of flammable gases resulting from the water gas reaction with coke so it is recombusted and the heat is recovered as steam.

The high temperature thermolysis of oil fractionation is generally thought to require fuel that is equivalent to 15-20 percent of the raw material oil. Since this method uses decomposition residual oil such as pitch and intermediate distillation cut, it is anticipated that the material balance for heavy oil decomposition will follow the pattern shown in Figure 2.

When paraffinic atmospheric pressure residual with a high yield of olefin is the starting material, there is very little decomposition residual oil formed. When reduced pressure residual oil is the raw material, there is considerable formation of residual oil byproduct. Most of this byproduct is consumed within the plant. In addition, there is the formation of excess pitch and intermediate distillation oil, and research on their effective utilization is one of the research items.

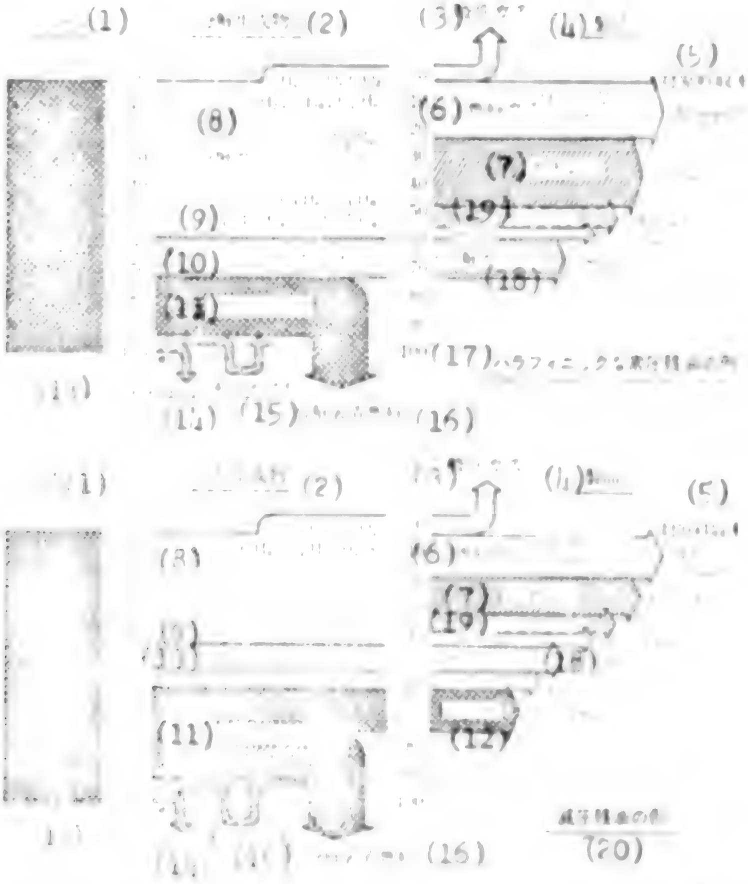

Figure 2. Material Balance for Heavy Oil Decomposition by the Coke Heat Medium Method

[key on following page]

[Key to Figure 2 on preceding page]

(1) raw material
(2) decomposition product
(3) acidic gas
(4) product
(5) yield based on raw material
(6) fuel gas
(7) ethylene
(8) decomposition gas
(9) 1.3-C_4H_6, other C_4
(10) C_5-200°C cut
(11) 200°C cut
(12)
(13) coke
(14) loss
(15) water gas formation
(16) decomposition facility fuel
(17) example of atmospheric pressure paraffinic residual
(18) decomposition gasoline
(19) propylene
(20) example of reduced pressure residuals

Point of Research and Development

The research and development program for this project is planned for the 7-year span from JFY 1975-1981, about 12 billion yen has been allocated for total research and development cost, and the objective is to design, construct, and conduct operational research on a 120 ton/day processing capacity pilot plant to obtain basic technology relative to long term stable operation.

When the scale of the pilot plant is converted to ethylene production capacity, roughly 5,500 ton/year is produced from reduced pressure residual oil starting material and about 10,000 ton/year with paraffinic atmospheric pressure residual oil starting material. This output is 24 times the yield of the test plant that was the forerunner of this pilot plant and roughly 1/10 the production of a single practical scale system.

Put briefly, the objective here is the establishment of technology for long term stable operation, and the following are the important research items.

1) Obtain information on large-size coarse particulate fluidized layer

2) Establish coking suppression method and decoking method

3) Establish methods for control of retention volume of heat medium coke, particle size, and properties

4) Developments such as quick cooling system for the decomposition products are the main points of this research and development. At the same time,

5) Obtain information on the decomposition characteristics of various types of raw material oils

6) Optimize processes such as heat recovery system

7) Study technology for effective utilization of byproducts from heavy oil decomposition.

Progress Situation to Date

Since the project was initiated in JFY 1975, the results of the forerunner test plant were used to plan and design a pilot plant. Production and purchase of the major mechanical equipment were initiated in JFY 1976, and construction of the pilot plant was initiated in JFY 1977. This pilot plant is being built on the grounds of the Kashima Plant of Mitsubishi Petrochemical Company, Limited, and construction is underway on a roughly 12,000 m^2 area.

The procurement of the mechanical equipment and installation of distribution were nearly completed during JFY 1978, and only the electrical, instrument, temperature control, and painting projects remain. It is expected that this construction project will be completed by the end of October 1979 and the project enter into the following test operations.

Various technological studies and preparations for operational research are underway at the same time with pilot plant design and construction operations, and the following are the major items in this category.

1) Engineering studies on various technical problems which are research topics

2) Consolidation of research items for pilot plant operational research

3) Study on pilot plant operating method and establishment of detailed operational outline based on the above

4) Study on methods for sampling, testing, analyzing, and measuring

5) Development of data processing system to process the vast volume of data from the pilot plant

6) Development of simulator to study pilot plant operation, conduct analysis, and study practical process

The greater part of the activities listed above were completed during 1978, and present activities are centered on final preparations for operational research in anticipation of the start of test operation in November.

In addition, research on the analysis of various types of heavy oil was initiated in JFY 1978 in line with the research on pilot plant operation. This research will be continued during this fiscal year and a new study on elucidating the coking mechanism has been initiated in which the analysis of properties of coking precurser material and research on properties analysis of decomposition residual oil (pitch) from among the decomposition products have been taken up.

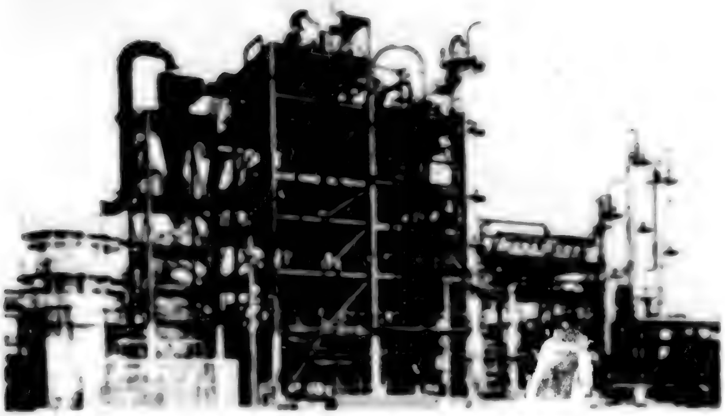

Photo 1. Status of Pilot Plant Construction (As of end of March 1979)

Future Research Plans

As mentioned before, this pilot plant is expected to be completed by the end of this October and directly followed by the initiation of test operation. Mechanical test operations will be conducted on the various equipment as well as water tests during November and December. The temperature will be raised for the studies in January-March 1980, and local tests will be conducted unit by unit passing actual oil through the system. It is expected to start true test operations conducting decomposition reactions in JFY 1980, and if the work on summarizing the results of the operational study is included, this research will be concluded near the end of JFY 1981.

Atmospheric pressure residual oil and reduced pressure residual oil will be used as raw material oil in the pilot plant operational research, and performance of the decomposition facility and other units, stability of operation, and possibility of long term operation will be subjected to demonstration tests. In this manner it is planned to acquire various types of operating data in preparation of practical application.

Parallel with the pilot plant operational research, technological studies on process improvement and plant scaleup will be conducted. In addition, test design of practical scale facility and technological and economic evaluations will be conducted from which it is anticipated that the possibility of practical application will be clarified.

In another direction, research on properties analysis of heavy oils will be concluded as of JFY 1979 while emphasis will be placed in properties analysis research on coking and decomposition residual oil during JFY 1980 with the research expected to be completed in JFY 1981.

Should these studies proceed smoothly, the goal of a practical method of producing olefins by the coke heat medium method should be realized at the start of the 1980s.

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PREPARATION FOR SERIOUS OPERATING RESEARCH

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 43-45

[Article by Toshihiko Maruyama, Head of Kashima Laboratory, Association for Research on Using Heavy Oil as Raw Material]

[Text] The large project "Olefin Production Using Heavy Oil as Raw Material pilot plant for which pile driving operations were initiated in June 1977 was about 90 percent complete as far as construction progress was concerned at the end of June 1979, and there is good promise that this construction will be completed by the end of October according to schedule. Even though this is a so-called pilot plant, it is of a very large scale requiring about 7 billion yen to construct, and the capacities of the units making up this facility taking up ground area of 12,000 meter^2 do not suffer in comparisons with the capacities of similar units in the general run of petrochemical plants.

Towers, tanks, heat exchangers:	about 150 units
Rotating equipment such as pumps, compressors, blowers:	about 200 units
Number of instrument loops:	about 800 loops

These are some of the equipment used, and the scale of this plant as seen from the specifications (Table 1) is one to rival that of a petrochemical production plant. In addition to this main plant, there are combustion gas treatment and condenser water treatment involved in products treatment and environmental countermeasures as well as waste heat recovery boiler, coke supply and disposal facilities, and pitch sample production facility which are secondary facilities that have to be operated at the same time. It is thought that research on the actual operation of this pilot plant will be of the same level or higher compared to a petrochemical production plant.

The schedule from here on includes individual test operation of the different equipment to be conducted from the end of this year to March of next year, test operation on one phase of coordinated operation, and finally actual operation using oil to start in April of next year.

Table 1. Comparison Between Olefin Pilot Plant and Petrochemical Plant

	olefin pilot plant	petrochemical plant A	petrochemical plant B
amount of equipment	387 units	368 units	425 units
towers, tanks, heat exchangers, heating furnaces	177 units	255 units	248 units
pumps, compressors, and other rotary equipment	210 units	113 units	177 units
number of instrument loops	824 loops	1,059 loops	704 loops
general control loops	258 loops	441 loops	195 loops
interlock loops	49 loops	201 loops	138 loops
others	517 loops	417 loops	371 loops

As is well known, the "Research Association on Technology Using Heavy Oil Raw Material" is dedicated to research and development on technology to produce chemical raw materials such as olefins in order to diversify petrochemical raw materials sources and was organized in July 1975. Its organizational chart is shown in Figure 1. The Kashima Laboratory was opened in January 1979 to serve as the sole organ where operational research on the pilot plant is to be conducted, and this laboratory is located on the grounds of the Kashima Petrochemical Complex (within the Kashima Plant of Mitsubishi Petrochemical). The rational for this site selection was the favorable raw material, accessory material, services, and decomposition products acquisition and disposal situation, and considerations for safety and environmental factors also entered into this selection. The raw materials, services, and decomposition products acquisition and disposition situation is shown in Figure 2.

The laboratory is staffed with outstanding scientific personnel dispatched from the laboratory, production, and design divisions of six private companies. There will be a total of 80 people of which 30 research personnel for technical analysis, research planning, and research management at the point of initiation of test operations at the end of the year, and it is anticipated there will be about 50 people directly engaged in the operational research.

There are a number of research organizations which have contracted large projects, but it is thought there are not many examples in which researchers of six private companies are brought under one roof and a large force of 80 people engages in pilot plant operational research. As seen from the standpoing of the laboratory director, "I have an organized mixed brigade and am

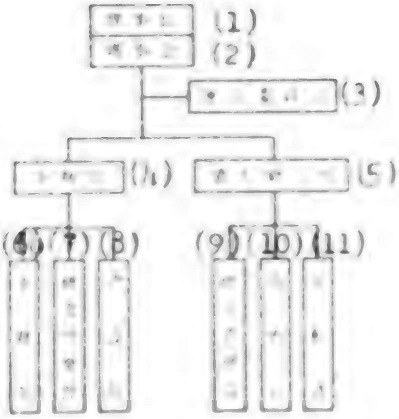

Figure 1. Organization of the Research Association on Technology Using Heavy Oil Raw Material

Key:
(1) President
(2) executive board
(3) administrative committee
(4) business office
(5) Kashima Laboratory
(6) business section
(7) research and development section
(8) construction section
(9) research control G
(10) technology G
(11) operations G

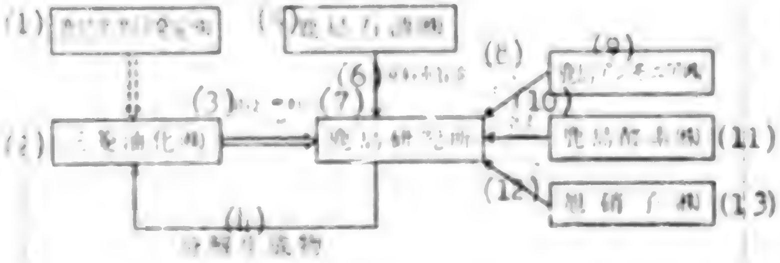

Figure 2. Procurement Relationships for Raw Material, Accessory Materials, Services, and Decomposition Products

Key:
(1) Kashima North Cooperative Power Company
(2) Mitsubishi Petrochemical (K.K.)
(3) services, fuel, others
(4) decomposition products
(5) Kashima Petrochemical (K.K.)
(6) raw material heavy oil
(7) Kashima Laboratory
(8) ammonia
(9) Kashima Ammonia (K.K.)
(10) nitrogen
(11) Kashima Oxygen (K.K.)
(12) caustic soda
(13) Asahi Glass (K.K.)

facing the battlefield" he has an attitude not unlike that of a commander going forth into battle. The elements for winning in combat are "harmony among people" and "how to focus the capabilities of the constituent personnel on the key points of the battle." The following operational policies were established for the opening of operations in April of this year.

1) Full engagement in the business at hand through enhanced solidarity

2) Complete elimination of safety, environment, labor, and fire hazards

3) Thorough backing for original ideas and energy conservation

As far as the first item is concerned, the rationale for the above element "harmony among people" is very evident here.

The next time to be seriously considered before entering into actual operational research is how to implement safety and environmental policies to the utmost. As stated in the saying "safety above all," every effort is being made to incorporate safe policies into the hardware and software areas to the utmost. Since this pilot plant is being used for operational research purpose, there is a high frequency of startups and shutdowns, the operating conditions vary with these frequencies, and the quality of the raw material heavy oil can vary thereby giving rise to some very disadvantageous conditions. Rapid response to these changes which can keep up in appropriate manner and the proper control become necessary together with suitable assignment of operating personnel. Should there be a large disaster, there will be not only human and material losses but, depending on the occasion, hazard to nearby people and possible pressure from public opinion which may make it difficult to continue operational research. At the same time, because the location is within a complex, there are the inevitable obstructions that are caused to the neighboring industries. As a result, we have taken the stand that we are a contract research organ for the country and will absolutely allow no accident to happen. It is the general case that chemical plant disasters occur from 1) process factors causing abnormal operating conditions resulting in fires or explosions, 2) deterioration or corrosion of plant equipment causing damage, blow-outs, oil leaks which lead to disaster, and 3) abnormal working conditions inviting labor disasters such as toxicity, burns, or injuries. Measures to prevent such disasters include 1) eliminate disaster causing factors in planned manner from the process design stage and complete an interlock that operates even during abnormal conditions, 2) make complete study of materials, specifications, and capabilities to prevent deterioration and corrosion at the time plant equipment is designed, 3) give operating personnel thorough education in safety and environmental countermeasures and thorough training in disaster prevention. In other words, all concerned personnel must cooperate wholeheartedly in taking up these measures to cover all stages from planning, design, production, construction, operation, and maintenance. This laboratory gives the operating personnel the training schedule shown in Table 2 before the workers even start on the work.

Table 2. Contents of Training Program for Operating Personnel Before Entering Actual Operation

Training Item	Contents
(1) process outline	a) explanation of process b) outline of research and development c) research operation plan
(2) safety, environment	a) safety, environment laws b) various standards c) examples of safety, environment troubles d) prevention measures
(3) basic operating knowledge	a) basic knowledge of chemistry b) basic knowledge of chemical engineering c) explanation of chemical processes
(4) materials handled	a) raw materials and addition b) products, byproducts
(5) operations outline	a) normal operation b) start-up--shutdown c) abnormal operations d) emergency shutdown
(6) examples of predicted troubles	examples training for each unit
(7) acquisitions of services, etc.	a) acquisition of raw materials, additives, products, byproducts b) acquisition of services
(8) equipment handling, instruments, electrical	a) handling of rotary machines b) basic knowledge of instrument and electrical equipment
(9) maintenance	a) specifications on equipment b) distribution line material
(10) various types of training	a) firefighting training b) emergency shutdown training c) hypothetic disaster training
(11) special activities	a) for startup and shutdown

Since heavy oil is used as raw material, environmental problems arise in the form of sulfur, nitrogen, and residual carbon materials and smoke, waste water, and waste solids which need to be managed. These discharges are processed in intensive manner when they are in a highly concentrated state at the generating source in the resourceful system which is employed, and they are all handled within the laboratory.

a) SO_2 Countermeasure

A sode absorption method is employed, and the desulfurization rate is better than 90 percent (about 50,000 Nm^3/Hr)

b) NO_x countermeasure

An ammonia reduction method is used to realize 80 percent denitrification rate (about 50,000 Nm^3/Hr)

c) Dust countermeasure

Dust is removed by passage through a dust collecting cyclone and by passage through desulfurization and dentrification plants.

d) Waste water countermeasure

Treatment using an oil separator and a dispersed water furnace bed method (water volume about 400 T/P)

e) Solid wastes countermeasure

Treatment in an incinerating furnace (36 T/D)

f) Odor and hydrocarbon countermeasures

Great effort will be made to maintain a closed system. When release is unavoidable, flare stack combustion will be used.

g) Noise countermeasures

Measures have been taken to keep machinery noise below 65 phons.

h) Others

Waste gas after undergoing treatment is exhausted to the atmosphere through a 200 meter tall stack.

As described above, this laboratory regards the engagement of all personnel in comprehensive safety and environmental measures necessary both from the standpoint of a contract research organ for the country and the maintenance of good relations with the neighboring society.

Japan's petrochemical industry has been producing olefins and aromatic compounds mainly from naphtha as raw material, but last year's Iranian change in government was a wedge which caused a rise in price and reduced supply. There is also the trend for crude oil to become more and more heavy in nature, and there is increasing clamor for the use of raw material in the form of heavy oil which makes up 50-80 percent of crude oil in contrast to the roughly 10 percent made up by naphtha. The petroleum situation is constantly changing, but no matter what its situation may be, there is need to establish the technology to produce olefins from heavy oils as quickly as possible, and this is the destiny of this laboratory. Petrochemical products are intimately tied in to the people's living, and they already have become indispensible from daily living habits. The creating of a pathway using abundant heavy oil as petrochemical raw material has significance from the standpoint of diversifying raw materials for the petrochemical industry that will surely contribute greatly to the national economy, and all concerned are resolved to put forth their best efforts.

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JET AIRCRAFT ENGINE PROJECT

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 46-47

[Article by Takeharu Takezono, Office of the R and D Officer, AIST]

[Text] Introduction

Jet engines which are sometimes referred to as the heart of aircraft have been the end result of the change from reciprocating engines to turbojets along about the end of the war, and there is today the fan jet engine which represents the highest level of technology at the present time.

The J_3 turbojet engine was developed starting in 1953 in Japan and is being used in training planes. In addition, the JR 100·200 engine for vertical takeoff and landing has also been developed. On the other hand, the development of a jet engine for commercial aircraft had not been started because of the lack of domestic demand, the large technological risk entailed in its development and the large sums required for development.

On the other hand the aircraft jet engine industry requires high level technology which straddles over many boundaries, and it is an industry that can be developed only by an advanced industrial country with a large number of superior technologists and with highly developed related industries. Furthermore, the results offer promise for application to other machine, metal, or electronic equipment industries, and its spin-off effect is very large. At the same time, it is thought that demand for airplanes will increase in the future.

In order to respond to this situation, a start on development of a domestic jet engine for aircraft industry based on domestic technology, and a plan to convert to technology-intensive industry are urgent subjects. There is special need to develop high performance fan jet engines with high operating economy and low atmospheric pollution due to noise and exhaust gas.

Outline of Research and Development

This project aims to promote the development of a high performance fan jet engine to respond to this present situation through a cooperative system involving production, academic, and government circles, and it was launched in 1971 under the large project system. The research and development can be grossly classified into research and development of engine elements and research on test fabrication (First Stage Plan) and research and development aimed at establishing the durability, reliability, environmental compatability, and high altitude performance of the engines developed (Second Stage Plan).

The First Stage Plan was implemented over the 5-year span from 1971 to 1975 in which a budget of about 6.9 million yen was allocated, and the initial objectives have been realized for the most part. On the other hand, operational research under the First Stage Plan was mainly in the form of performance and capability tests, and total test time did not exceed 250 hours. Operational research extending over several thousand hours is necessary to check out durability, safety, and reliability, as is the practice in other countries.

The Second Stage Plan is aimed at the development of a 7-ton thrust class fan jet engine based on the hardware technology developed during the First Stage Plan, trends in world jet engine development and trends in demand. It was started in JFY 1976 for a 6-year period with an estimated budget of 18.5 billion yen. Operating research will make up the bulk of the Second Stage Plan efforts, and ground performance and capability tests, endurance tests, environmental compatability tests, and extraneous objects intake tests will be conducted along with low temperature and low pressure tests using a high altitude performance test facility. The engine performance and reliability under all kinds of conditions will be established. In addition, research on the reduction of noise and toxic gas emission will be conducted in line with the demands of the times.

Progress Status of Research and Development

The First Stage Plan saw the fabrication and assembly of six engines including the primary test engine (4.5-ton thrust) and the second test engine (5-ton thrust). The targeted performances were virtually all realized for thrust, fuel consumption rate, fan pressure ratio, turbine inlet temperature, bypass ratio, noise level, and exhaust smoke concentration. Design and fabrication of hardware of a top level in the world were realized.

As the Second Stage Plan was entered, operational research on engines test produced during the first stage was continued, and at the point where 3 years have gone by, performance and capability tests, endurance tests, and environmental tests have logged a total of 1,200 hours. What should be specially noted here is the high altitude performance test conducted in the fall of 1977 at the United Kingdom's National Gas Turbine Laboratory (NGTE) in which engine performance, ignition limits, and range of safe operation during

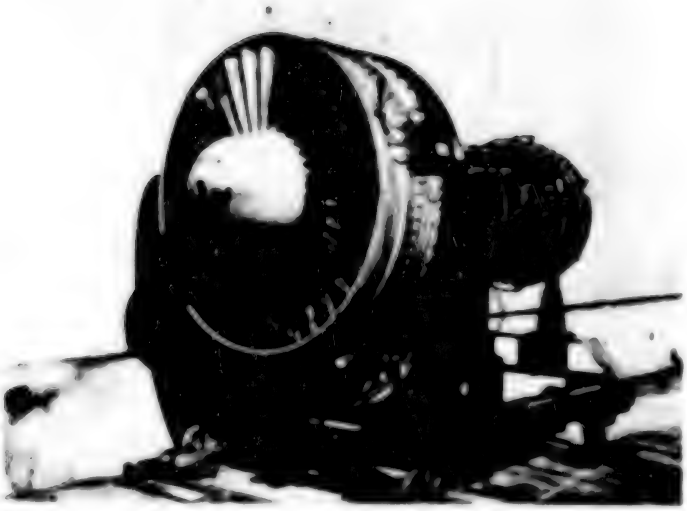


Photo 1. First Test Fabricated Engine of the Second Stage

sudden acceleration and deceleration along with system operating states in high altitude performance tests at low temperature and pressure were conducted from which very effective and important data were obtained.

While reflecting the results of this operational research, fabrication and assembly of two units of the first test-produced engine (5.5 ton thrust) were completed in which limiting design taking into account great increase in thrust and decrease in weight was incorporated. Performance demonstration tests are under way at the present time.

Final Statements

In faithful execution of a national project to develop a fan jet engine, within Japan's aircraft industry, the foundations for an engine industry must be laid and a shift in part to knowledge-intensive industry must be made. If we hypothesize entry into the future world market, the day may be near when an earnest study needs to be made on the possibility of international cooperative development because of the vast sums of money required prior to commercialization and the need to spread development risks.

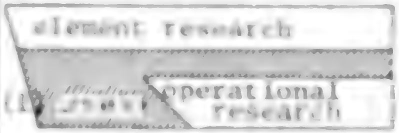
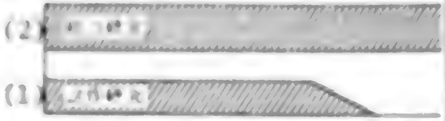
Plan	SCHEDULE 46 47 48 49 50 51 52 53 54 55 56	REMARKS
Large project First stage plan	 first test engine completed (FRJ710/10) second test engine completed (FRJ710/20) performance demonstration test preliminary endurance test, about 250 hours	Emphasis was placed on research and development on engine elements and test fabrication research during the first stage plan. Operational research is the demonstration of the results of this element research and test fabrication research
Second stage plan	 first test engine completed (FRJ710/600)	results of first stage plan serve as basis for engine operational research
	performance, capability tests ground based endurance tests environment compatability test (extraneous material intake test, corrosion resistance test, high and low temperature startup tests) low frequency fatigue tests, high altitude performance tests, for about 7,000 hours	research and development on engine endurance, reliability, environment compatability, and high altitude performance to demonstrate adequate safety and reliability

Figure 1. Long-Term Research and Development Plan for Aircraft Jet Engines

Key: (1) test fabrication research
(2) integrated research

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AIRCRAFT JET ENGINE R&D AT NATIONAL AEROSPACE LABORATORY

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 48-49

[Article by Masakatsu Matsuki, Chief, Engine Department, National Aerospace Laboratory, Science and Technology Agency]

[Text] The National Aerospace Laboratory is a subordinate organ of the Science and Technology Agency, and it is Japan's only research organ on matters pertaining to aircraft. This laboratory has been going into all out cooperation in projects related to aircraft, and it is participating in the large project on jet engine for aircraft research and development that is being conducted by the Agency of Industrial Science and Technology that is under the Ministry of International Trade and Industry. It has been pursuing research and development activities since the first stage plan (JFY 1971-1975). It was in charge of research and development on the fan engines during the first stage (fan, high pressure compressor, combustion unit, high pressure turbine, low pressure turbine, fuel control, etc.) and it provided results for use in various designs for the test production of engines. At the same time, it was in charge of rigidity tests, vibration tests, and operational research on the main structural components of the test produced engines. It conducted research on improving engine performance and endurance along with research directed at reducing noise. As the second stage is being entered, it has been conducting research directed at reducing noise, reducing emissions, and studying inlet distortion as well as promoting research to improve the performance of the different elements. It is also cooperating in operational research. The major research programs are described below.

Comprehensive Research on Noise Reduction

Basic research on sound absorbing plates was conducted along with the clarification of the noise characteristics of the test produced engines. Test production of sound reducing nacelles was conducted, and research on reducing engine noise is being pursued. The noise measurement facility at the Tsunoda Branch site of the National Aerospace Laboratory is pictured in Photo 1. Material useful for lowering noise of fan jet engines was obtained from these studies, and noise reduction technology is being promoted.

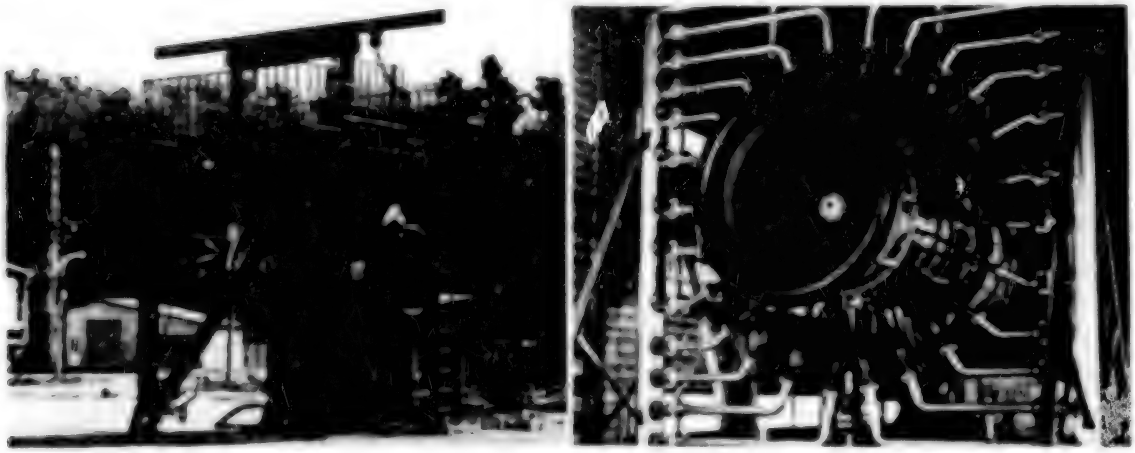

Photo 1. Noise Reduction Test with Noise Reduction Nacelle (Tsunoda Branch Laboratory)

Comprehensive Research on Emission Reduction

The combustion unit of a fan engine is small and light, and it is also a high temperature and high pressure combustion unit. First of all, outlet temperature uniformity and durability are necessary engine elements. In addition, smokelessness and low toxic materials content in the exhaust gas also are necessary attributes. Lowering NO_x emission is a particularly difficult problem, and research along this line and on durability are the most important programs underway.

Research Related to Inlet Distortion

a. Research on Inlet Distortion

Changes in engine performance when there is nonuniformity in intake air of the engine due to factors such as crosswind during takeoff or landing and vibration of the fan impellor were clarified, and research is being directed at clearly defining the permissible limits of operation. A test facility with a number of air jet nozzles to create nonuniformity in intake air is illustrated in Photo 2. There is also an outdoor facility presently under construction which will direct a crosswind during engine operation.

b. Research on Fans

Solitary experiments were conducted directed at roughly 75 percent reduction in scale of the fans for the first and second test produced engines, and the aerodynamic properties were determined. At the present time, research on design of new fans with sufficiently high pressure ratio even to the inside is being promoted to improve performance and reduce weight.

c. Research on High Pressure Compressors

High pressure compressors have particularly good performance at high speed, but a wide range of stable operation even at low speed is important. Research on a high pressure compressor with improved pressure ratio at the inlet and increased air flow is being promoted. At the same time, research is being pursued on improving the performance of multiple stage high pressure compressors with better air extraction at the intermediate stages and improved performance at the blade tip gaps.

d. Research on High Pressure Turbines

Research is being promoted on improving the aerodynamic performance of turbines which operate with high pressure and high temperature gas and on air cooling the blades. Research on blade cooling is not limited to only improvement in cooling performance but also to reduce thermal stresses on the blade during the non-normal states associated with sudden accelerations and decelerations.

e. Research on Low Pressure Turbine

Aerodynamic tests conducted on actual size four stage low pressure turines served to clarify the performance of multiple stage turbines under a wide range of operating conditions. Even further improvement in performance and high load capability are being targeted, and a rotating blade array test using blade models aimed at reducing loss at the wall surface is being conducted.

f. Research on Fuel Controller

Research is being promoted on an electronic combustion controller to replace the mechanical fuel controller being used at the present time. The operating conditions are set as close as possible to simulate flight conditions, combustion is finely controlled, and fuel consumption is lowered, and the life of the high temperature materials will be extended if the objectives of this important research are realized.

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JAPAN AND U.S.-EC DIFFERENCES IN AVIATION GAS TURBINES R&D

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 49-51

[Article by Mototusgu Ito, Deputy Chief, Technology Development Department, Aerospace Division, Ishikawajima-Harima Heavy Industries, Ltd.]

[Text] Introduction

More than 8 years already have elapsed since development on aircraft jet engines was taken up as a large project. The development of engines for commercial planes which at one time seemed so far away has now reached the stage where the goal is in sight.

The development of the fan jet engine FJR 710 via the large project system is being promoted by the Agency of Industrial Science and Technology which has enlisted the cooperation of government, academic, and private industry people, but there is the situation that this project has a number of keenly felt problems which are unique when compared to the research and development situations in the western countries.

I will try to introduce a few of the problems which I have been anguishing over, and I would have them taken as supplementary materials for considering what our future posture should be.

Military Aircraft and Commercial Aircraft

It is well known that the continuous and fast paced development of technology associated with the practical application of gas turbines for aircraft use over the past more than 30 years was mostly in the form of research and development on military aircraft.

First of all, gas turbines for aircraft were the product of research and development aimed at their use in military aircraft alone. The tragic accident suffered by the Comet (British) engine that was the first application to commercial aircraft is well shown, but this engine as well as the engines used in the United States to first power the B707 were jet engines from military sources applied directly or after subsequent modifications to commercial use.

Even today's first line engine, the CF6 made by the GE Company uses the TF39 engine high pressure system originally designed for the C-5A military plane coupled with a newly designed fan for commercial use. The JT9D product of Pratt and Whitney Company is an engine developed from the JTF14E that failed the competition with the TF39 for use on the C-5A.

A more recent example is the CFAA-56 under joint development by GE-SNECMA which will use as is the high pressure system of the F101 engine developed for use on the strategic bomber B-1 whose development was halted.

The examples given above are cases in which the entire military engine or parts of it were taken over and converted to commercial use, but even in more indirect ways the development of commercial engines owes some debt to the blessings of the military in one way or the other.

Taking the case of the United States, the Department of Defense in purchasing engines for military use only required that involvement in research and development, and [R & D] funds were allotted as a ratio of the purchase price with no specific use in mind in the system adopted. Even assuming that the funds were used on research and development specifically on military aircraft engines, the elements making up the engine and the material working technology, when considered in detail, are difficult to classify as being strictly military or commercial, and it is clear that the vast military acquisitions of the American military were serving as the foundation to foster commercial aircraft. While the fine details cannot be given here, there has been similar influence on commercial aircraft from military aircraft in the European countries as well.

Next, it can be said that research and development on the elements making up the engines being conducted by the western countries were not directed at specific aircraft but to the raising of technology on types which have promise for future application using research and development funds obtained from the military.

As discussed above, when one looks at the situation in detailed manner along the lines of the elements making up the engine, it is not possible to differentiate the technology between military and commercial, and the net effect is that the results of all research along this line can be directly applied to commercial use.

In line with what has been said thus far, there is a handicap or fate of gas turbines for commercial planes which has evolved from the pattern of their development. That is to say, commercial engines were born from military parentage particularly during the early phase of their development, and it naturally follows that the nature of military planes and engines is such that should an accident occur it can directly entail injury to humans. And, since most of the money for their development came from military sources, development basically was not geared for commercial use. These premises were assumed as part of the basis for setting prices.

As the 1960 decade was entered and the political and military tension relaxed, the effectiveness of manned aircraft came under question as a result of which the pace of development of military aircraft slowed. The accompanying blessings to commercial aircraft decreased as a result (although this varies, depending on plane type).

On the other hand, the mechanism for pricing was not altered once it was established, as a result of which strictly commercial planes with no military background had to bear the brunt of huge development costs and yet compete in the price competition established by the marketplace.

The small jet engine J3 for the intermediate trainer of the Defense Agency is the only mass produced engine developed in Japan after the war. At the same time, all the research and development which have been described to this point were of very modest scale compared to what took place in the western world.

These events partially reflect Japan's unique situation as well as being the result of our industrial capability, and it would not be reasonable to leap to a conclusion based on the above. On the other hand, as long as the situation described above exists in the leading countries of the western world, the long term fostering and strengthening of the aircraft engine industry will have to be considered a national policy. The development of the FJR710 under the large project system should be accompanied by research and development on par in quality and quantity with the research and development efforts directed at military aircraft in the western countries.

Role of National Research Organs

When the aircraft engine research and development systems of the various western countries and Japan are compared, one of the points which can be thought to represent a major difference is the role of the national research organs.

One example which can be cited here is the central role played by NASA in the United States. There are two major functions which NASA has in its favor which the Japanese national research organization does not possess. One is the capability to coordinate and assign research and development activities for the entire country. The other is the assistance it lends on technological problems which directly confront the aircraft engine industry.

With respect to the first point, NASA has drawn up an all inclusive program for long term research and development of jet aircraft engines taking into account the governmental, academic, and private aspects and has divided the program into research and development to be conducted by NASA itself, research and development to be conducted by other governmental research organs, research to be contracted to universities, and research and development to be contracted to manufacturers. When seen from a nation-wide view, this avoids gaps in the research and development theme and every effort is made to conduct research and development avoiding duplication as much as possible.

The second point is that in reduction of noise and reduction of the toxic components in the exhaust gas and the volume of the exhaust which are problems facing the industry, research and development on select existing selected models to reduce these emissions is contracted out to the makers of these engines and thereby aided. Assistance is provided by farming out to manufacturers the research and development on structural factors that hold the key to improving the performance of future civil aircraft.

It seems that a similar function has been given the NGTE of the United Kingdom and many of the governmental research organs of the western world.

The various governmental research organs in Japan all are conducting high level research, and we in industry are utilizing the fruits of their research. On the other hand, the capability discussed above is lacking, and comparison with the leading countries of the western world leaves us in a disadvantageous situation as far as development of airplane engines for commercial use is concerned.

Research and Development Facilities

Another sore point in this present research and development of the FJR710 jet engine is the lack of research and development facilities and capacity and capability inadequacies.

Fortunately, the development of FJR710 has resulted in facilities such as engine test site, high pressure combustion test facility, crosswind test facility, and ice and bird intake test facility which were indispensible to aircraft gas turbine development being built and expanded, and this is a very pleasing situation for which we have the people of the Agency of Industrial Science and Technology to thank.

On the other hand, comparison with the leading countries of the western world reveals that Japan still lacks many facilities such as a high altitude performance test site, large capacity aerodynamic performance test facility for various components, and test facilities for endurance and rigidity tests of parts.

It is unreasonable to provide all these research and development facilities for a single project such as the FJR710, but a long term plan for facilities such as mentioned above is desirable.

Summary

This has been a discussion of the agonies and hopes of the people engaged in the development of gas turbines for aircraft use. This paper can be condensed to say that the western countries receive the benefits derived from the development of military aircraft which are passed on to their commercial aircraft, which for the most part is not available to us in Japan. It is hoped that research and development on gas turbines for aircraft use which requires much information accumulation and has particularly high add-on value be conducted under a long term project of national scale so that there will be no slips from the laying of the foundation to the realization of the practical stage.

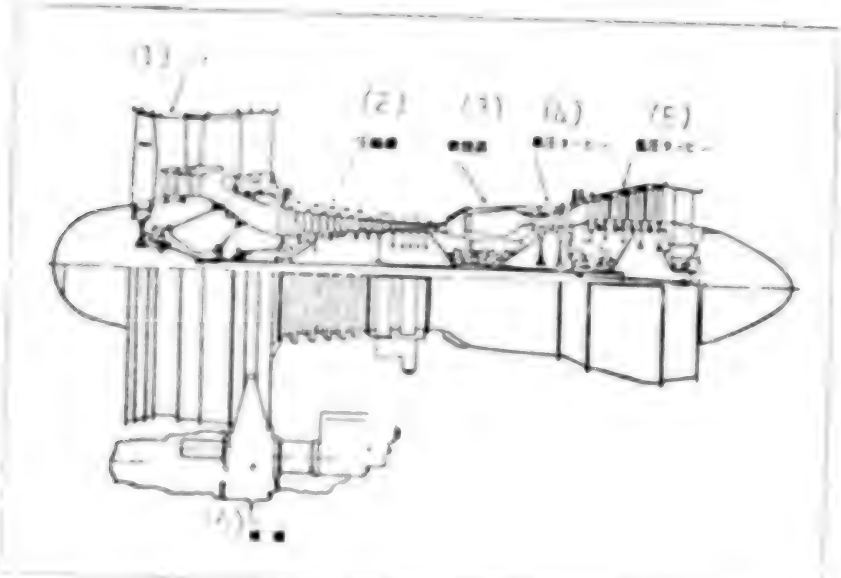

Figure 1. Conceptual Diagram of the First FRJ710 Engine Test Producing During the Second Phase

Key:
(1) fan
(2) component
(3) combustor
(4) high pressure turbine
(5) low pressure turbine
(6) support

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RESOURCE REUTILIZATION TECHNOLOGY SYSTEM

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 52-55

[Article by Hideaki Takamatsu, Office of the R and D Officer, AIST]

[Text] Introduction

Japan's industry has produced a period of economic growth not seen before in the world through the utilization of abundant resources imported from overseas, but the so-called oil crisis was the wedge which has made difficult any economic growth of a multiple resources consumption nature. The oil crisis was not a sudden phenomenon, and a similar fate is expected to befall not only oil but other natural resources, and it is expected that future supplies will be greatly controlled by the international situations. In the midst of such a background, Japan is a country of very limited domestic resources, and it must depend on overseas sources for most of its supply while trying to maintain a stable economic society. If this is to be maintained, there must not only be a conversion from a multiple consumption of resources situation to an information collecting situation along with all out promotion of technological development on methods of effective utilization of resources and stockpiling of resources. At the same time, man's activities are inevitably accompanied by the production of wastes. Mass production and mass consumption which raised the people's standard of living have not only increased the volume of wastes but have varied the types of wastes produced. If these wastes are left as is, it is clear that the living environment will be destroyed. This is why the promotion of "research and development of reutilization of resources technology of urban solid waste" as one phase of the industrial technology policy is thought to be an important policy subject whose time has come. The results of this research and development are expected not only to resolve the many problems associated with the management of solid wastes from our cities but to contribute toward the development of resources recycling technology which is a technology directed at the conservation of resources and which is an important research subject along the lines of energy conservation and reduction in load on the environment compared to the utilization of virgin resources.

Contents of Research and Development

The following are the basic developmental targets of this research and development.

1) It will manage in all inclusive and efficient manner mainly the mixed and concentrated urban solid waste to conserve resources and minimize pollution.

2) It should be able to recycle a considerable fraction of the wastes as material resources and energy resources.

3) It should satisfy nonpolluting conditions necessary to protect the environment.

4) It should be safe and be comparatively easy to service and supervise.

5) It should take into account side benefits accruing from reutilization and should be of advantage costwise compared to the treatment methods employed at the present time.

6) It should be highly compatible with the social system.

The following research and development mode has been adopted.

There will be the two prototype technology systems of reutilization of material resources and reutilization of energy resources, and a large pilot plant (about 100 t/day capacity) will be designed, constructed, and operated to establish the necessary technology for each of these systems.

Research and Development on the Material Recovery Process System

A considerable fraction of urban solid waste will be mainly regenerated as material resources through a nonpolluting and safe all inclusive and efficient urban solid waste management technology sytem that will be developed through research and development entitled "material recovery type process system research and development." A pilot plant is being constructed at Kanazawa-ku in Yokohama-shi and is named "Stardust '80'" which is expected to shine as the start that will pilot the urban waste reutilization technology of the 80s.

The flowsheet of this process is shown in Figure 1.

The process is explained in order below.

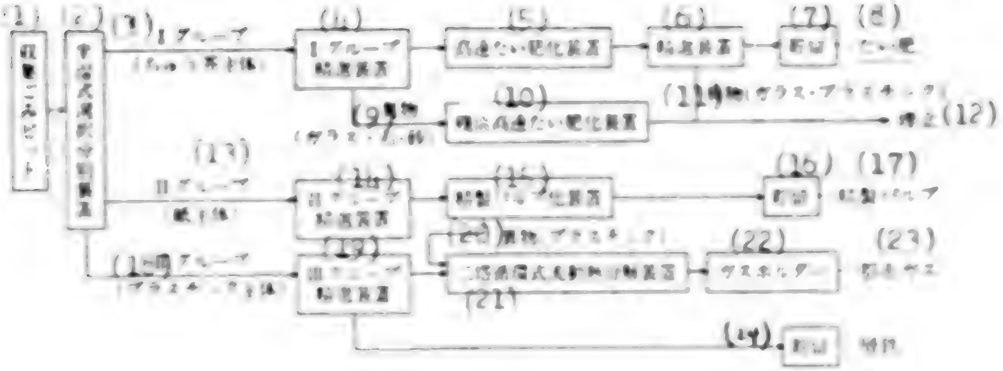

Figure 1. Flowsheet of Material Recovery Type Process System

Key: (1) trash collection pit
(2) semiwet selective sorting facility
(3) Group I (mainly garbage)
(4) Group I fine selector
(5) high speed composter
(6) fine selection device
(7) storage
(8) compost
(9) extraneous material (glass, pebbles, sand)
(10) high speed composter of residuals
(11) extraneous material (glass, plastics)
(12) burial
(13) Group II (mainly paper)
(14) Group II fine sorter
(15) purified pulping facility
(16) storage
(17) purified pulp
(18) Group III (mainly plastic
(19) Group III fine sorter
(20) extraneous material (plastic)
(21) 2-tower circulation type flowing heat decomposition facility
(22) gas holder
(23) urban gas
(24) storage, scrap iron

1. Sorting of Urban Trash (Pretreatment System)

The important unit of the pretreatment system is the semi-wet selecting, crushing, and sorting facility of the type whose principle is illustrated in Figure 2. It consists of two types of sifting plates in which a rotating drum with two screens of differing mesh is rotated at a speed differing from that of a rescreening drum in which the mixed trash is directly along the axial direction of the drum as the differences in impact resistance, pressure resistance, and shear force of the different materials are utilized in crushing and sieving the particles as they pass by.

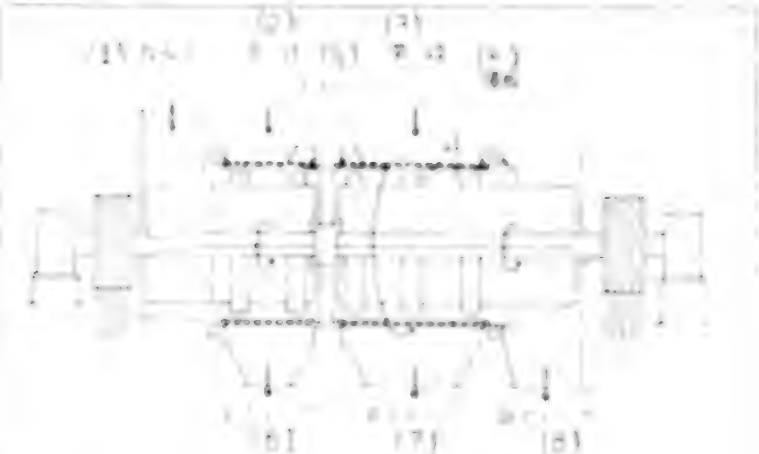

Figure 2. Principle of Semi-wet Sorting and Separating Facility

Key: (1) trash inlet
(2) first stage
(3) second stage
(4) screen
(5) scraping plate
(6) group I
(7) group II
(8) group III

The mixed trash tossed into this facility is, first of all, subjected to breakdown of its most brittle and weak components such as garbage, dirt and sand, and glass at the scraping plate as it passes through the first stage screen and is discharged (group I). The remaining trash is heated as it passes through the drum, to be impacted, sheared, and crushed at the scraping plate, and paper wastes weakened by this heating are selectively discharged through the second stage screen (group II). The remaining materials of greatest ductility such as metals and plastics are discharged at the terminal section of the drum (group III).

7. Trash for Composting (High Speed Composting Subsystem)

The treatment by which garbage separated from the main body of trash by pretreatment is converted into organic compost similar to fertilizer is called the high speed composting subsystem.

The garbage is placed in a fermentation vat, and it is stirred for a given duration while air is passed through to activate the fermentation process whereby the material is converted to a low odor compost, and pieces of glass and small bits of plastic are removed. The material obtained in this manner is cycled to fields, paddies, and orchards which have become impoverished and not only abet the production of tasty crops but also eases the problem of final interment which is the most sticky of the treatment process.

The compost prepared in this manner has the following composition.

Nitrogen (N)	1.6-2.3 percent (by weight)
Phosphate (P_2O_5)	0.8-1.2
Potash (K_2O)	0.7-3.1

3. Purified Pulp from Trash (Purified Pulp Subsystem)

The subsystem not only removes bits of plastic, string, hair, and garbage adhering to the paper separated from urban trash but also disinfects, bleaches, and produces purified pulp. The purified pulp obtained in this manner can not only be used to manufacture paper but in other new uses envisioned for pulp.

The paper production capacity of Japan at the present time is 15 million tons/year and pulp production is of the order of 10 million ton/year. When this is converted to raw material wood which provides the original pump, roughly 30 million cubic meters is required, and this is nearly all imported. In addition, the pulp and paper industry consumes an extraordinarily large amount of energy. According to data from JFY 1975, about 5.87 percent or 6.584 million kiloliters of the total heavy oil consumption of 112.14 million kiloliters is consumed while 8.27 percent or 20.228 million kWh electric power out of a total of 244.64 million kWh is used at the same time. Furthermore, the volume of waste water produced by the pulp manufacture process places no small load on the environment. On the other hand, assuming that 10,000 tons of pulp is recovered from trash, this is equivalent to a saving of about 80 kiloliters of heavy oil. In addition, it is equivalent to saving roughly 240 hectares of forest area.

4. Gasification of Trash (Two-Tower Circulating Type Thermolytic Subsystem)

This subsystem converts the plastic fraction separated by the pretreatment subsystem in efficient manner into high calorie (7,000 Kcal/m^3) fuel gas. The thermolytic gasification facility of this subsystem circulates a fluid medium (sand) between two towers to absorb the heat released by the trash and conduct combustion reaction and this is why it is called a 2-tower circulation thermolysis process).

This technology uses trash considered unsuitable for present day incinerators in the form of plastics as raw material for conversion into good high calorie gas.

Energy Recovery Type Process System

There is increasing number of examples in which the steam from the incineration of trash or the steam left over from power generation is used to heat greenhouses or supply hot water, but the rate of utilization is very low because of the difficulty in storing electricity and heat.

This is why research and development on an energy recovery type process system to replace incineration is being conducted in parallel manner in this resources recovery and reutilization technology system.

This research and development is aimed at converting and recovering a considerable fraction of the mixed and concentrated urban trash as an energy source (fuel oil, methane gas).

First of all, an example of the compositional analysis of an urban trash sample is shown in Figure 3. The heat emission from single component is shown in Table 1, and the fraction convertible to energy in the form of combustible material will release 36.4 percent energy or 1,458 Kcal/kg which is low. The high moisture and incombustibles content has resulted in the design of a process in which microorganisms are used to generate methane gas which is thought more suitable for trash of high moisture content taking into consideration the problem of storing and transporting energy for the total energy recovery system. This process flow is shown in Figure 4.

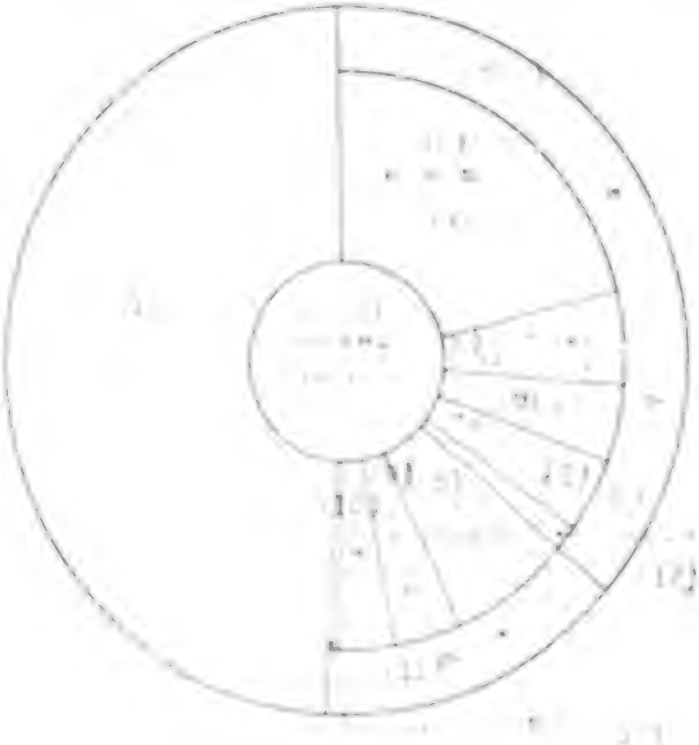

Figure 3. Example of Composition of Urban Trash

Key:
(1) moisture content (6) garbage (10) metal scrap
(2) waste paper, etc. (7) wood scrap, etc. (11) incombustibles
(3) combustibles (8) glass, ceramic scrap (12) filters
(4) low heat emission (9) sand, pebbles (13) egg shells, clam shells
(5) plastic scrap 15.6% (of which 0.5% is vinyl chloride)

Table 1. Heat Emission from Unit Components of Urban Trash

type of unit component		heat emission
paper waste	paper cardboard corrugated cardboard	4,270
garbages	garbage	4,250
	vegetable matter	3,970
	shells, bones, etc.	--
plastics		7,550
leather, rubber		6,500
fibers		4,500
wood, bamboo		4,700

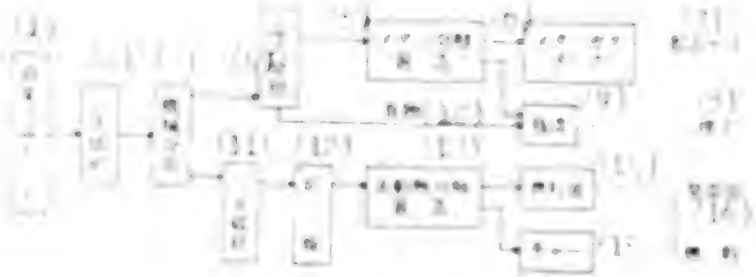

Figure 4. Flow of Energy Recovery Process System

Key:
(1) trash collection pit
(2) first grinding
(3) mechanical separation
(4) wet separation
(5) methane fermentation unit
(6) methane gas tank
(7) city gas
(8) burial
(9) residue
(10) extraneous matter
(11) second grinding
(12) drying
(13) fluid thermolysis unit
(14) fuel oil
(15) char
(16) fuel for electric power use

1. Pretreatment of Trash

An energy recovery type resources regeneration and utilization technology system is without merit unless the energy recovered is greater than the energy expended in the recovery. Thus, the cost of treatment must also be less than the energy recovered by the incineration mode. This is why the pretreatment used in this system empties the mixed trash in bags (first grinding) and sorts the trash mechanically into garbage, other organic materials (plastic), and paper. The garbage fraction is separated into material fermentable into methane gas and extraneous material at the wet separation facility. The other organic materials are subjected to a second grinding, dried by the off gas excess from fluid thermolysis, and used as raw material for the thermolysis.

2. Methane Gas from Garbage (Methane Fermentation Subsystem)

When one approaches any municipal trash dump, he sees a stack rising above the dump, and this stack is used to disperse methane gas generated by the putrefaction of garbage in soil into the atmosphere. This subsystem employs a new type methane fermentation technology (two-tank type) which converts garbage into methane in short order. This process first takes the garbage slurry into the first tank (liquefaction tank) where the garbage is liquefied by alkaline decomposition (or acidic decomposition) and the liquid goes to the second tank (gasification tank) where it undergoes fermentation to methane and produces methane gas. High quality methane can be obtained in efficient manner.

Substitute Trash for Fuel Oil (Liquid Thermolysis Subsystem)

The subsystem takes the plastic and paper separated from mixed urban trash and subjects them to fluid thermal decomposition to mainly transform the material to fuel oil which is then recovered. The excess steam and off gas heat generated by the thermolysis are utilized in heating the fermentation vat of the methane generation subsystem and in the drying of trash. This is equivalent to converting excess heat from incineration into recovered oil which is then stored.

Basic research has been completed on all these subsystems, pilot plant (treatment capacity 100 ton/day) basic design has been drawn up, and the situation is ready for starting production design and construction.

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CITY GARBAGE WET SORTING TECHNOLOGY DEVELOPMENT

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 56-57

[Article by Tadao Moro and Hiroshi Sakamoto, Third Resources Department, National Research Institute for Pollution and Resources, AIST]

[Text] Introduction

Assuming that the outstanding status of trash management is the conversion of the various components making up trash into resources, there will be enhanced precision in the separation into individual components within the permissible economic range allowed under a social system, and the various components can be cycled back as high quality raw materials for production of high quality products, and this may possibly be best suited to the objectives of the resources recovery and utilization system.

Under the stand just described, this laboratory is planning the development of wet treatment technology which in principle should make possible higher level of sorting and separating. A specific objective is establishing the validity of the secondary sorting technology of the flowsheet for the demonstration plant of this project.

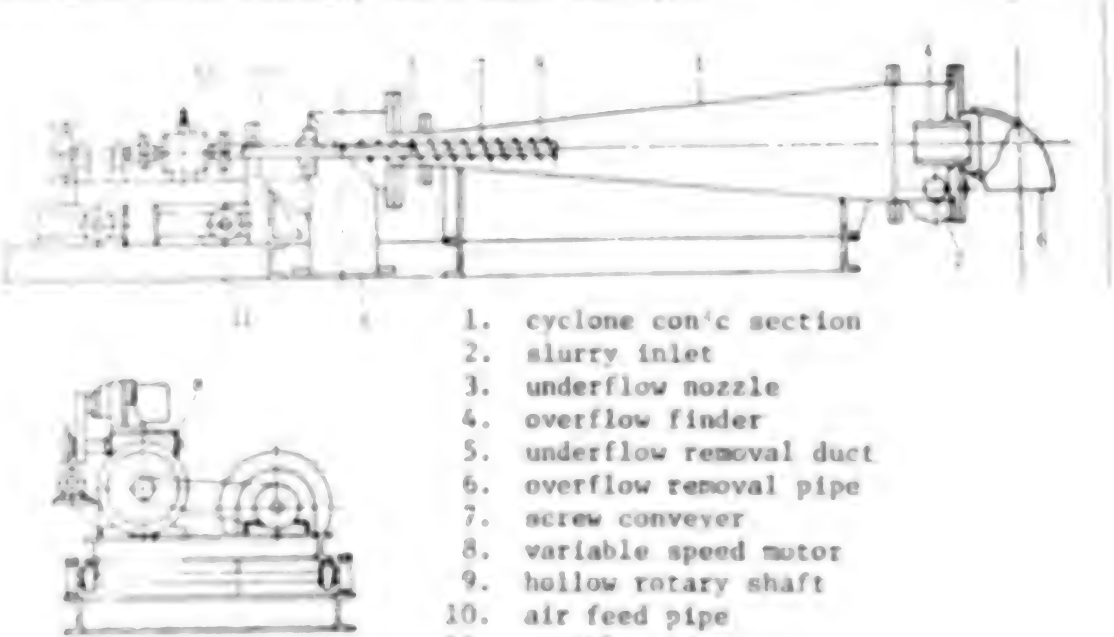
That is to say, the development of an open type eddy flow sorting facility to handle loose trash employing a pretreatment device in which are contained a forced exhaustion cyclone sorting device and a material recovery system (called MRS) for the pretreatment of high concentration trash slurry for the methane production subsystem of the energy recovery system (called ERS) are included.

This present research was started in 1976 as support research for the second stage (demonstration stage) of this project and is already into its fourth year, and the first stage product is at the stage where it can be made practical. Because of certain limitations including space, the following discussion will be focused mainly on the forced exhaustion type sorting device.

Development of Forced Exhaustion Type Cyclone

(Purpose) This facility is designated to remove glass, dirt and pebbles, and heavy extraneous matter from the garbage that has undergone first stage selective separation at a wind power sorting device (or a mechanical separator) and serve as the pretreatment facility before the garbage is fed in as raw material for the methane fermentation process. Since technology development aimed at more efficient operation through high concentration and high temperature treatment was promoted in the methane production process, development of a selection facility effective even in the high temperature region was also requested.

(Construction) The makeup of this facility is shown in Figure 1 in which there is a screw-type exhaustion device with a hollow shaft at the underflow section of the usual type cyclone. Air is supplied through this hollow shaft whereby an air wick (air column) is formed within the cyclone and maintained, and any lowering in sorting capability is prevented. At the same time, a concentration process at the underflow section smoothly removes solid materials which have lost their fluidity via a screw conveyer.



1. cyclone conic section
2. slurry inlet
3. underflow nozzle
4. overflow finder
5. underflow removal duct
6. overflow removal pipe
7. screw conveyer
8. variable speed motor
9. hollow rotary shaft
10. air feed pipe
11. movable bed
12. torque gage

Figure 1. Construction of Forced Exhausting Type Cyclone

(Characteristic) This facility possesses the following characteristics compared to the usual type cyclone.

Since it is capable of high pressure treatment intended for handling high concentration slurries, sortings of greater efficiency and precision are possible.

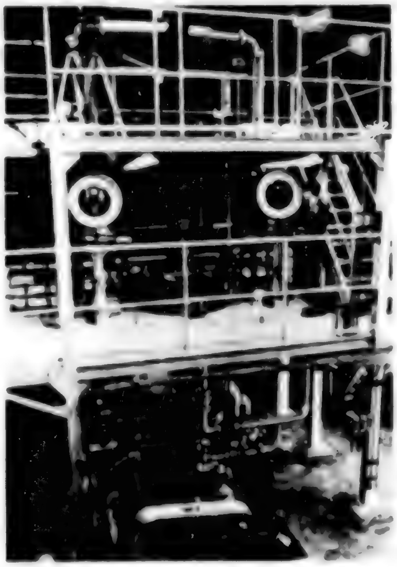
Since it can make possible realization of both high level concentration and stable operation (preventing stoppages), the water content of underflow products can be lowered.

The adjustment of screw turning speed and air flow enable adjustment of the selection conditions. At the same time, it can react in an appropriate manner to a wide range of changes in properties of the feed slurry (treatment raw material).

(Experimental) A performance test was conducted using a pilot plant (see Photo 1) with treatment capacity of 120 m^3/hr (maximum). The dimensions of the cyclone were 320 mm inner diameter and 10° taper to the conic section. Parts with different diameters and pitch were used for the screw section. The basic tests were conducted mainly with low concentrations of old paper and glass slurry.

(Performance) An example of the separation capability of the forced exhausting type cyclone on low concentration old paper-glass system is shown in Figure 2. According to this figure, the size of particles separating from this forced exhaustion type unit depended on the slurry inlet pressure just as with the standard type cyclones, and the same values were obtained at suitable screw rotational speeds. In addition, the results of slurry treatment experiments using actual urban trash clearly showed that employing high pressure conditions with slurry inlet pressure greater than 2 kg/cm^2 enabled suppressing the size of separating glass particles to less than 1 mm at an organic material concentration of 9 percent that is the set value for the methane formation subsystem. In other words, introducing this facility as a pretreatment to the methane production process made possible simplifying the flowsheet and decreasing the size of the facility.

Photo 1. Wet Sorting Test Plant



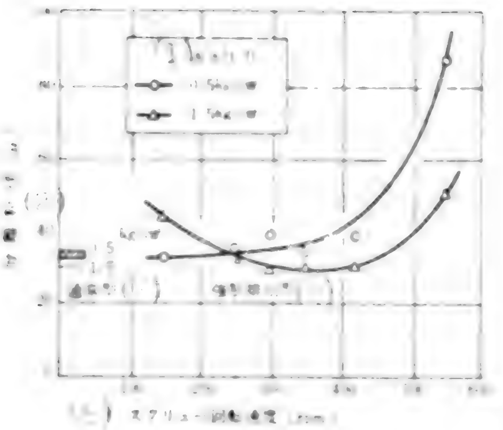


Figure 2. Example of Separating Capability of Forced Exhaust Cyclone

Key: (1) inlet pressure
(2) separating particle size
(3) usual type
(4) forced exhaust type
(5) screw rotational speed

(Application to Other Areas) It is thought that this facility, in principle, makes possible higher concentration, sorting, and stable operation compared with cyclones used in the past, and many other applications are expected in addition to the treatment of urban trash slurries. For example, it may be applied to city sewer treatment where slurries containing similar fiber type material can be treated to recover fine bones (deslime) from sand and pebbles. In this manner, it should be very effective in various processes, and research is being conducted to make practical application in many different areas.

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RECYCLING PAPER FOR PULP

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[Article by Takashi Yoda, Central Research Lab, Diashowa Engineering, Ltd.]

[Text] We are in charge of "Purified Pulp Production" that is part of the large project on material recovery type resources recovery technology system along with Tsukishima Machine. The contract for this work was signed in JFY 1976, and we are now entering our fourth year. Construction of the demonstration plant was completed in JFY 1978, and operational research was initiated in JFY 1979. During this period, the work during JFY 1976 was devoted to basic research for basic design while JFY 1977 was taken up by system design research. The purpose of this research is to regenerate sanitary pulp for paper making from city trash and to set up a regeneration technology necessary to the process. This program is not limited to research for a limited time period but also development, and we are forever looking for fresh possibilities and testing out actual and practical situations. This is why not only the latest equipment is being assembled for the process of producing purified pulp but equipment from the past is also incorporated in order to develop the most reliable system.

Understand Human Complexity Through Visual Sorting

Our system does not involve the removal of pulp material from the raw trash but is concerned with raw material in the form of the paper fraction (mostly old paper) as it comes from the sorter. Compared to the process in which old paper generated in households is used as raw material to produce pulp, the raw material for this present process contains several times more extraneous material (rubbish), and we are surprised at the quantity of garbage still remaining. Put in an extreme manner, it is processing paper contained in trash. A visual sorting was performed in order to measure the distribution of various components in this trash. This involved air drying the trash after which paper and plastics and other junk present were sorted and separated visually. While the trash was being air dried, bad odor (characteristic garbage smell) filled the room, and some people nearly gagged. During this visual process, pieces of religious ceremonial paper or hair were found, and the sorters were subjected to a number of thoughts. The separation of hair from paper and other extraneous matter was extremely difficult, and it often required considerable effort to separate these pieces. These remnants from human life reflect in accurate manner the complexities of human life.

Battle with Extraneous Matter

The composition of raw material for pulp recovery obtained through visual sorting was made up of about 85 percent paper on the dry basis, and the remainder was plastic, rubber, wood scraps, bamboo, straw, hair, and garbage. We started off on our pulp making technology relying on the process of making pulp from old paper as the basis of reference. On the other hand, the fraction of extraneous matter was much higher than that encountered in pulp production from old paper. Further, contamination with extraneous matter such as garbage was so severe that it was not possible to use a method exactly the same with that used in the recovery of pulp from old paper used in the past. Because of the high content and the complex makeup of this extraneous material, the screen used to sort the trash clogged at very high frequency. In addition, we struggled to separate paper from pieces of string and hair.

Scrap twine and pieces of hair are long and fibrous and have densities very close to that of pulp fiber so that they passed through the screen along with pulp rather easily making their separation difficult. There was need to study their behavior in order to successfully remove them, and our tests started off using a drum scale operation. Test errors were repeated as we struggled to improve the removal rate. Similar difficulties were experienced in the removal of plastic scraps, hot melt materials, different oily materials, and garbage extraneous matter.

Raw Material Is Mixture of Various Types of Old Paper

The types of paper contained in the starting material covered a wide array, and its makeup consisted of roughly 50 percent newspapers and magazines while the rest was corrugated cardboard, white cardboard, kraft paper, and high quality paper. Old paper has traditionally been used as part of the starting material for the production of cardboard. Recent advances in old paper regeneration technology and effective utilization of resources have resulted in their use to produce newsprint paper and medium quality paper. Old paper used as raw material for paper production is used as starting material according to the nature of the paper itself, and old newspapers are used to produce fresh newsprint paper while cardboard is used to produce more cardboard. The papermakers purchase old paper in sorted form for this type of production. The raw material for producing purified pulp is in the state of mixture of various kinds of old paper as was described above. Recycled pulp obtained from raw material of this composition naturally is closer in quality to pulp regenerated from old paper than from virgin pulp, and it has quality closer to regenerated pulp from old newspapers and magazines, corrugated cardboard, and old paper. The objective of producing purified pulp is to obtain pulp usable for paper making while city trash contains a mixture of many kinds of paper, and it has been said that pulp produced from such a mixture of low grade and high grade paper may not be suitable for paper making. It has been difficult to refute such a statement. Just as white note paper is produced from pulp which has been bleached with chemicals and newspaper print is on paper made mostly from mechanically pulped material from wood chips, paper is made up of a wide variety each made from some special line of pulp.

Photo 1. Facility Used to Break Up Raw Materials Used in the Research

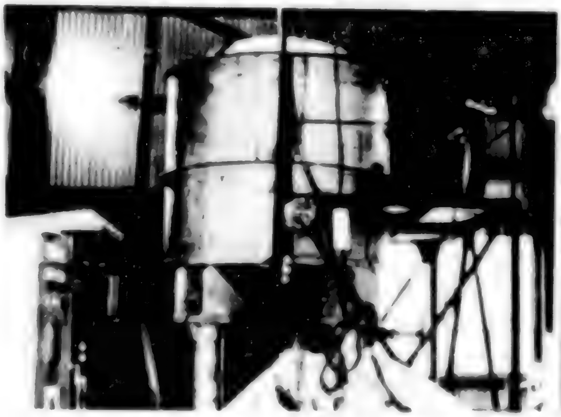
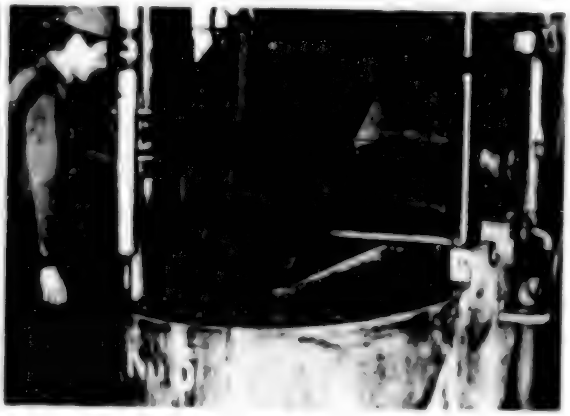


Photo 2. Working Situation in the Research (Finished Purified Pulp)



Practical Application of New Pulp

Purified pulp manufactured from this type of raw material consisting of a varied array of old paper undergoes removal of extraneous materials, removal of odds and ends such as dust and hot melt, and various bactericidal treatments using bleaches and other purification processes to get to the purified pulp stage. As mentioned before, this pulp may be considered a new type of pulp in contrast to the varieties of pulp used to make paper from different types of used paper. This is why not only the paper making end but also some new uses for this pulp can be anticipated. Pulp is an intermediate product be it for paper making or some other application. The purpose of producing purified pulp is just that, and it is not involved with pulp making. On the other hand, the product so obtained is a new type of pulp, there is need to use the purified pulp from a demonstration plant to actually make paper products from which feedback on the quality needs to be obtained. There is also need to actually produce new products from this purified pulp, availing this product for examination by the average user so he can actually feel the product in a PR approach, promote PR to paper making companies who will probably be using this product on a large scale, and promote PR to related organs and government circles in order to enable practical application of this new pulp. At the same time, it is thought that every effort must be made to erase the negative psychological effect associated with products made from city trash.

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MODULAR PRODUCTION SYSTEM USING HIGH PERFORMANCE LASERS

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[Article by Hideo Inoue, Office of the R and D Officer, AIST]

[Text] From the Showa 30 decade (1955-1965) and continuing through the Showa 40 decade (1965-1975), competitive development of mass production technology aimed at automabile production and household electrical appliance production has continued between the countries of the world, and the high productivity automated production and finishing system, foreshadowed by these transformations, has undergone eyeopening technological advances. Japan placed great emphasis on this development of mass production technology enabling it to win in its technology development race with other countries and establish the foundation for today's export-oriented production setup.

As the 1975-1985 decaded was entered, the development race related to production technology has focused on automated systems which can produce small quantities of several different products rapidly and in flexible manner. In other words, attention is being directed at the development and bringing to the practical stage an automated production system of high flexibility. As will be discussed later, this change has as its background the rationale for the small volume, multiple product production mode and the shift in demand for various products of varying properties.

In the past, any request for small quantities of different products requiring flexibility in production methods was shunted off to certain experienced technicians. The principle figures in all areas were the people, and any time there were differing features in the products to be turned out, the changes in operations were handled completely by the workers' ability to adapt to the situation.

On the other hand, this approach was saddled with the shortcoming that it was difficult to rationalize the system and install conservation measures. At the same time, it was difficult to install partial automation or modification of facilities to improve productivity in spectacular manner. There were also problems such as the lack of experienced technicians or unfavorable work environment caused by operations requiring considerable contamination or hazardous conditions. When one considers that roughly 70 percent of total production of the machine industry is taken up by large variety and small volume production, the economic effects of the development and practicalization of a flexible automated production system assumes extremely great importance.

There has been need for greater versatility up to now even in the area of industrial products thought to be mass produced, and this need is increasing. For example, taking the case of the passenger automobile, the variations for a single model will amount to 50-100 if the many requests on the part of users are to be honored, and it is impossible to produce such a wide array by the present standardized mass production approach and remain economical. In other words, the time has come when the introduction of a flexible automated production system has to be considered in order to respond to these various requests while reducing the number of production lines to the minimum level.

The start to the establishment of an epocmaking production technology for multiple product small volume production evolving from this background is the large project research "Modular Production System Using High Performance Laser." Intensified efforts already are being directed at development of flexible automated production systems in the United States, West Germany, and the United Kingdom, and it is thought that the results of this technology development race in the area of multiple product small volume production will be tied in to the establishment of superiority in the world's market on the part of Japan, United States, and Europe. This is why the promotion of this large project research has very great significance for Japan which must rely on trade to survive.

Outline of Research and Development

Research and development on the large project "Modular Production Using High Performance Laser" has been planned for a 7-year period from JFY 1977 through 1983 and a budget close to 12 billion yen has been assigned. As mentioned before, the object of this project is to establish the technology necessary for the development of a 'modular production system" which will enable flexible and rapid production of many products in small volume through an integrated mechanical assembly.

The feature most important to multiple product small volume production is the "flexible and rapid" capability. What is termed flexibility here refers to a flexibility that makes possible free modification of the production process to comply with the production of a number of different products. This flexible and rapid treatment capability is a common objective throughout all the research items of this project and is based on specific modular construction.

A flow sheet showing the relationships between the development and research items of this project is presented in Figure 1. There are seven items of element research necessary to the development of the modular production system. These are the total system, cutting technology, base shape forming technology, automated assembly technology, laser application technology, automated diagnostic technology, and automated design technology. Element research on the various research items will be essentially completed by the end of JFY 1980, and the results will be used to conduct detailed design of an experimental plant, production, and operational evaluations over the following three years starting in 1981.

The research themes for JFY 1979 are paired off with their counterparts in the modular production system makeup in Figure 2. As is clear from this figure, this project has as objectives a very wide area of production technology.

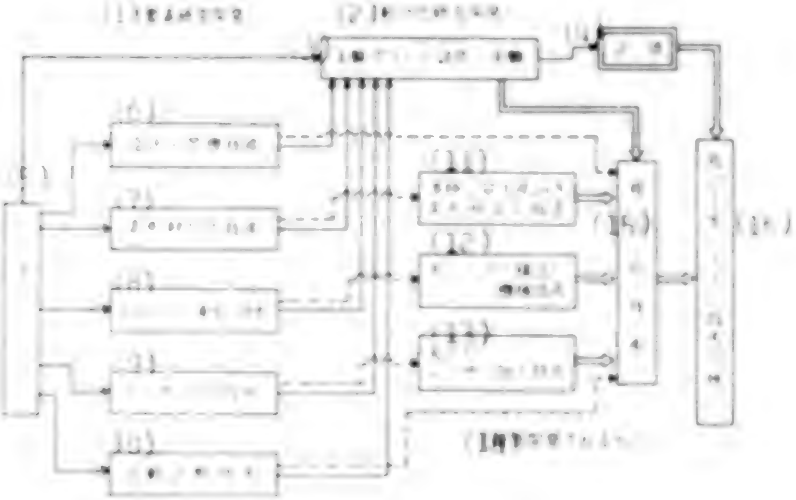


Figure 1. Research and Development Flow Diagram for the Modular Production System Using High Performance Laser

Key: (1) element R and D
(2) comprehensive research and development
(3) construction and testing of test plant
(4) evaluation
(5) total system
(6) design, management technology
(7) base shape forming technology
(8) cutting, automated assembly technology
(9) laser application technology
(10) automated diagnostic technology
(11) base shape forming technology directed at multiple variety small volume production
(12) modular construction machine technology
(13) high output laser fabrication technology
(14) (items for research and development)
(15) modular technology
(16) establishment of modular production system technology

The different research items and their associated subjects and their present status are described below.

Research and Development Subjects

1) Total system

Research is being supervised to establish system design and control technology for the modular production system. This includes research on establishing system plan, production mode, and system control and operating mode as seen from material flow and information flow extracted from the basic mechanism of the modular production system.

2) Cutting Technology

The cutting mechanism of this modular production system needs to be able to respond in flexible manner to varied production parts which can be imagined as whole bodies. Consequently, there are many kinds of cutting operations required, and this involves different types of cutting according to the nature of the product in question, and its volume will vary greatly. As a result, the cutting mechanism for the modular production system will consist of constitutive elements each with a unit module of single capability all of which are manufactured in a single specified dimensions, and the capability specifications and work space specifications are also incorporated into the modular unit assembly which is one of the many making up the whole. In other words, a modular unit construction is employed.

An example of a modular unit with improved flexibility as the result of free engagement and disengagements between units is shown in Figure 3.

The modular construction to be developed by this project will have the capability of separating and coupling in automated manner a number of units in short order in addition to which it must satisfy the necessary ruggedness, operational capability, and precision required of tool machines as a result of which high level technological development is required. In order to resolve these technological problems, servo motors for small units and control devices making up tool machine element groups are the objectives of research and development as illustrated in Figure 2.

3) Base Shape Forming Technology

The point of development of base shape forming technology which can withstand the flexibility required for multiple product small volume production is to develop metal molds of flexible structure and free forming technology requiring no molds.

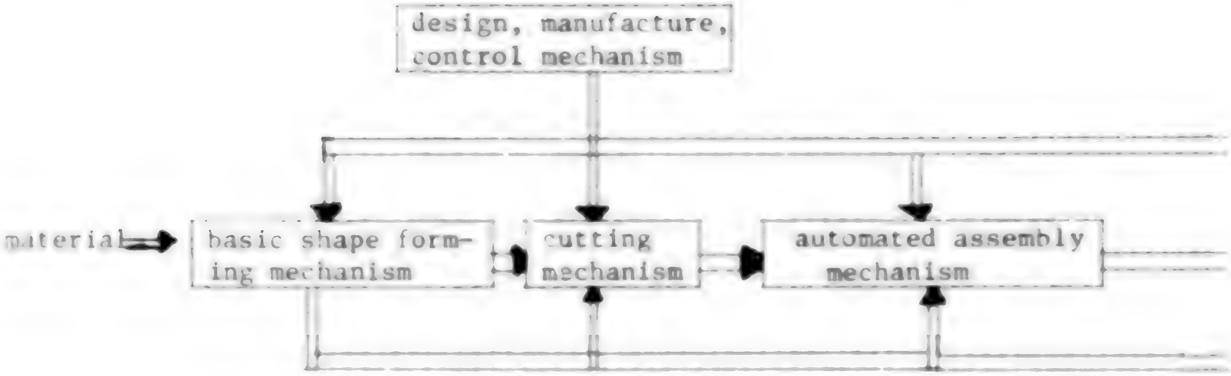
A representative example of the former that comes to mind is the assembled metal mold. The adoption of the use of metal molds of a single structure used in the past to multiple product small volume production would increase production costs to very high levels.

R & D on total system

(1) design research on total system

R & D on design and management technology

(1) research on automated design technology
(2) research on process design and management technology


design, manufacture, control mechanism
material
basic shape forming mechanism
cutting mechanism
automated assembly mechanism

R & D on basic shaping technology

(1) research on metal molds for flexible construction
  - research on shaping technology using metal mold assemblies*
  - research on powder forming technology*
(2) research on free forming technology
  - research on pipe modular working technology*
  - research on ultrafree forging technology
  - research on hot isostatic pressure powder forming machines
  - research on disk ring forming technology
(3) research on composite shape forming mechanisms

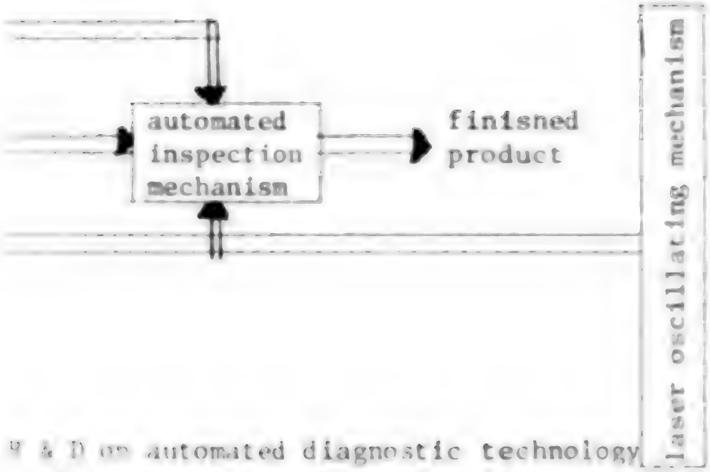
R&D on cutting technology

(1) research on design technology of modular production machinery
  - research on production properties of modular production machinery*
  - research on new modular structure pieces*
  - research on structural joining technology*
(2) research on technology for high grade tools
  - research on grinding tools*
  - research on cutting tools*
(3) research on modular cutting mechanism
(4) research on technology to obtain higher cutting capability
(5) research on general attachment technology
(6) research on control systems and drive systems

R&D on automated assembly technology

(1) research on assembly control technology*
(2) research on modular assembly technology
(3) research on control of modular assembly mechanism

Figure 2. Modular Production System Using High Performance Laser and Its Research and Development Themes (JFY 1979)



R & D on laser application technology
(1) research on control technology for high output laser oscillator*
(2) research on triaxial direct crossing CO_2 laser
(3) research on biaxial direct crossing CO_2 laser
(4) research on optical parts for laser use (fabrication and evaluation tests)
(5) research on optical parts for laser use (production of metal mirror fabrication)
(6) research on optical parts for laser use (development of alkali halide materials)
(7) research on optical parts for laser use (development of Groups II-VI compounds)
(8) research on medium output laser oscillator
(9) research on laser fabrication technology (research on laser welding, cutting technology)
(10) research on laser fabrication technology (research on laser surface treatment technology

R & D on automated diagnostic technology
(1) research on malfunction diagnostic technology
(2) research on precision compensation technology
(3) research on automated inspection technology
(4) research on precision diagnostic technology*

(Note) * indicates theme under supervision of AIST

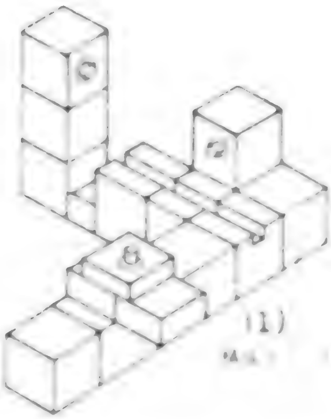


Figure 3. Modular Unit Construction Mode

Key: (1) constitutive unit

In order to resolve this type of problem, metal molds have been broken down to obtain basic metal molds of simple shape which are then put together according to the need at hand. Should these assembled molds become applicable to all types of shaping, the versatility and economic aspects of shaping technology will be improved greatly.

Free forming technology brings to mind disk ring technology, ultrafree casting technology, and hot isostatic pressure powder forming technology.

4) Automated Assembly Technology

The first thing to be considered under automated assembly technology is that this technology must be capable of assembling a product of a quality at least equal to or better than that of a product presently available in the market. Should the performance or external appearance be wanting, there is no value no matter how high the productivity or low the cost that can be realized.

The assembly process is generally the final process, and any damage to the product as the result of improprieties at this stage is equivalent to sacrificing the parts that had been fabricated and accumulated to this stage, and there is no way to compensate for this.

This is why when automated assembly is being studied, it is the usual practice to take adequate consideration of the possible mixing in of dust and other extraneous matter from the surroundings, the shape of the item, and the precision of working of the many parts making up the product; select a mechanism to be used in the assembly which has proved very reliable in the past; and set up any exclusive plan in order to obtain technology which will insure quality products.

When one thinks along these lines, the practical comprehensive automated assembly units on hand today are exclusive facilities for mass produced products in which the shape and size of the products do not change.

Now the automated assembly technology for the modular production system which this project has taken up has the objective of establishing, in place of the present automated assembly of a single product, a multiproduct small volume automated assembly technology.

The capability to respond to multiple product low volume production demands is equivalent to establishing assembly of all kinds of ordinary products. If this ability is to be enhanced, the present assembly technology needs to be analyzed from its operational viewpoint and to study just how far a decision capability necessary to the assembly operation needs to be pushed after which the necessary mechanism and controls should be developed.

Assuming that several products are to be assembled in automated manner, there are the associated technological problems such as the supply of parts to go into the products being assembled, the transport of the products, and the tools to handle the products that are assembled. Since these problems arise from technology developed for the single process single machine morphology of the past, it is difficult to adapt the technology directly.

The minimum use of transport of products and performance of several assembly operations at a given site constitute the so-called modular assembly, and there is need to incorporate into its mechanism intelligent decision making capability and flexible control which selects any desired operation along with the capability to select the optimum tools for a given assembly and make necessary replacements.

5) Laser Application Technology

Lasers represent a new technology which is still roughly only 20 years since its first development. It is applied presently to make measurements and to conduct fabrication operations followed by applications in communication, information processing, and medicine thereby covering a wide area.

When lasers are applied to modular production, the applications which come to mind include measurements, surface treatment, cutting of material, welding, and heat treatment. The development of a large output carbon dioxide gas laser oscillator and establishment of its control technology for working metals are in order. Research is being promoted in this project on the development of a 20 kW class carbon dioxide gas laser oscillator of practical performance for fabrication, the development of optical parts to be used with large output lasers, and the establishment of laser fabrication technology.

6) Automated Diagnostic Technology

The abilities to monitor the states of the system and products and to propose a remedial measure quickly when the system departs from normal operating states are necessary for the production system to operate in normal manner and continuously produce the intended items. Automatic diagnostic technology is an indispensable technology from the standpoint of the operation of such systems.

Accident diagnostic technology requires the capability to observe any incidence of system malfunction and to stop operations and display the type of malfunctions.

Technological development is under way in the area of research on precision compensation technology to make precision compensations based on the results of precision diagnosis. Developments are anticipated in elucidation of the factors responsible for errors arising from unit interchanges in modular structures and the establishment of precision compensation technology for varied products.

Research on automated inspection technology is directed at the development of capability to automatically inspect various products along various lines which probably will be produced by the modular production system, draw up a record of the inspection results based on inspection standards, and make reject decision when necessary.

Research is under way in the area of precision diagnostic technology on siting of fabrication machinery, measurement and experiments on precision, and precision measurement methods.

7) Design and Management Technology

Research is being conducted on automated design technology for ordinary use, evaluation of the operating state of modular production systems, process control technology for optimization, and establishment of optimum process design technology for the modular production system.

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SEABED OIL PRODUCTION SYSTEM R&D

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[Article by Kaoru Honjo, Office of the R and D Officer, AIST]

[Text] The Agency of Industrial Science and Technology took up research and development activities on the theme "Seabed Oil Production System" under the Large Industrial Technology Research and Development System (large project) starting last JFY, and it will be engaged in this program on a 7-year plan up to JFY 1984.

(Total research and development funds about 15 billion yen)

What is meant by seabed oil production system is the system technology for recovering oil and natural gas from oil wells under the sea to be accomplished by the installation of main production equipment at the sea bottom in a system with the major feature of not requiring platforms.

At the present time, nearly all the oil taken from the sea bottom is through these fixed type platforms, but this platform approach necessitates greatly increased use of steel as the depth becomes greater as well as greatly extended construction period which are necessarily associated with shortcomings due to technological and economic problems. Because of this situation, this present project seeks to establish technology employing a new production mode which does not require platforms and thereby enable oil production from very deep ocean oil fields.

Need for Research and Development

Oil production from seabeds is increasing year by year, and this source now provides about 20 percent of the free world production since the 1970 decade. It is expected that this figure will increase to 30-50 percent in the future.

It is clear that the ratio of oil recovered from seabed oil fields will increase more and more while there will be a gradual move to center new development to recovery of oil from oil fields at even greater depths.

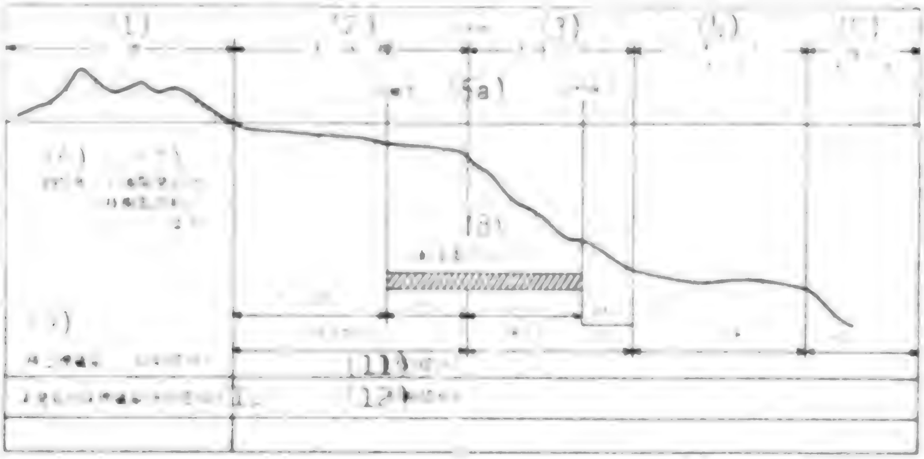
In this situation, Japan is most backward in production technology among the prospecting, drilling, and production technologies which make up seabed oil production technology, and it is to develop this area that efforts are being directed to break through the limits of operable sea depths for present technology.

To this end, Japan is conducting research and technology on new technology for the production of oil from sea bottom oil fields. This technology then will be used to promote the development of oil resources on Japan's continental shelf and slopes. At the same time, financial and technological power will also be directed at fostering oil development projects overseas. With this background, it was decided to embark on research and development on the "Seabed Oil Production System" starting last JFY. Research and development is now underway by a concentration of both government and industrial circles including Japan's oil development industry, shipping companies, and heavy equipment makers.

Outline of Research and Development

1) The seabed oil production system to be developed by this project is the system technology for producing oil and natural gas from the sea bottom oil fields which is difficult by present day technology, and one of its main features is that it will involve the installation of the principal production equipment on the sea floor rather than on a fixed platform (see Figure 3).

Figure 1. Seabed Oil Resources in the World



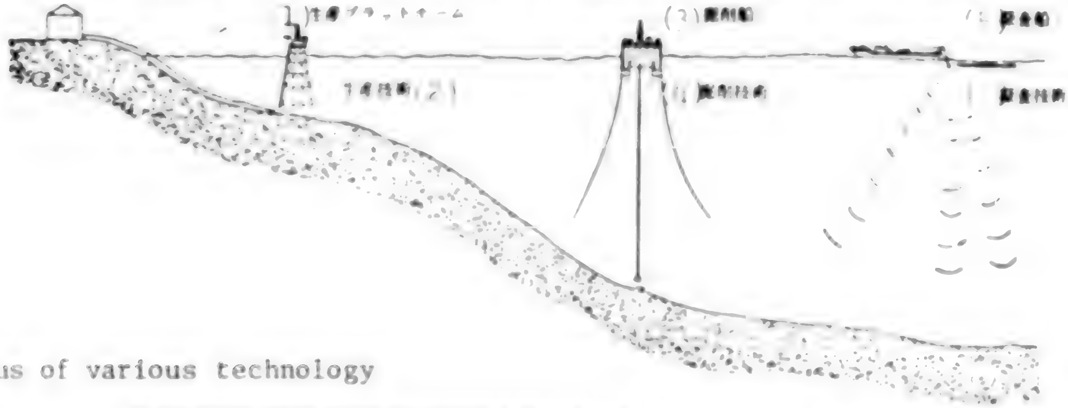
According to Weeks (1974) and Moody the maximum potentially recoverable seabed reserves in the world totals 50 billion bbls (25 percent of total) with some bias in distribution, and the presently undiscovered fields account for 69 percent which shows the late stage of development compared to oil fields on land where only 38 percent is as yet undiscovered.

[Note continued and key on following page]

According to data put out by the National Petroleum Council of the United States (NPC), World Petroleum Council (WPC), and the United State Geodetic Survey (USGS), it is estimated that continental shelf reserves (200-2,000 meter depth) amount to 55-70 percent up to 200 meters and 90-98 percent up to lower edge of the continental shelf.

Key:
- (1) land
- (2) continental shelf
- (3) continental slope
- (4) continental rise
- (5) plateau-deep
- (5a) nautical miles
- (6) 1975
- (7) from technical data supplied by Japan Petroleum Development Corporation
- (8) most important section (75%)
- (9) proven reserves 604.5 billion bbl
- (10) undiscovered recoverable reserves 585 billion bbl
- (11) 135.5 billion bbl
- (12) 378 billion bbl

Figure 2. Present Day Technology for Developing Seabed Oil Fields

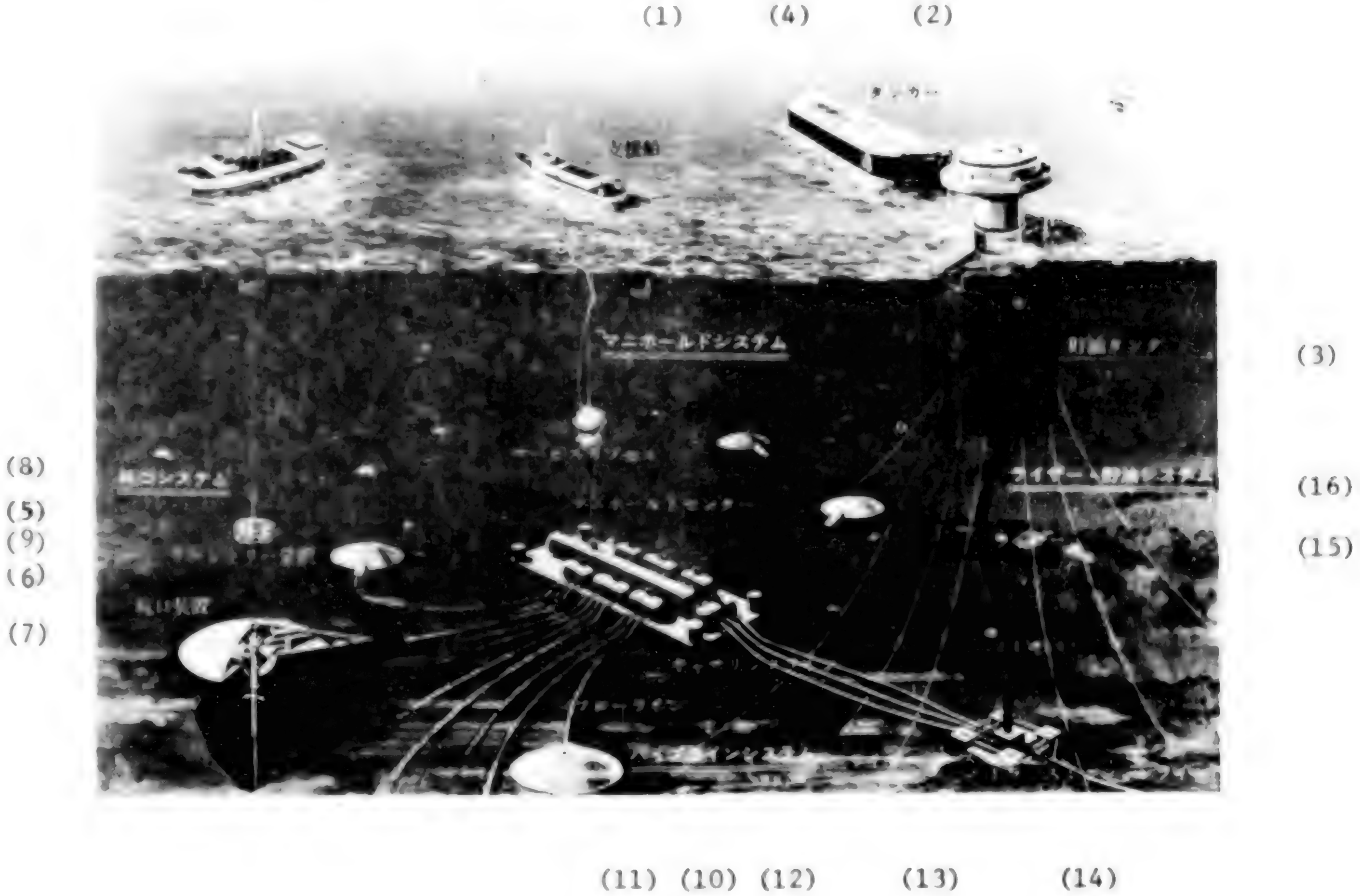


status of various technology

	Japan		Other countries	
	depth attained	Remarks	Other countries	Remarks
prospecting	2,000 mm	seismic prospecting by the Kaiyo Maru	2,000 mm ~ 7,000 mm	under study
drilling	2,155m	results from Teikoku 0.1 in the Okinawa coastal area using ODECO8	1,055m (3.461 ft)	attained by EXXON Co. off coast of Thailand by Discoverer 534
production	80 m	fixed platform off coast of Aga	143 m (470 ft)	wet type seabed well completed in the North Sea (Prent) oil field

Key:
- (1) production platform
- (2) production technology
- (3) drilling ship
- (4) drilling technology
- (5) prospecting ship
- (6) prospecting technology

Figure 3. Conceptual Diagram of Seabed Oil Production System



Key:
(1) support ship
(2) tanker
(3) oil stroage tank
(4) manifold system
(5) wellhead system
(6) reentry facility
(7) wellhead equipment
(8) service capsule
(9) manifold center
(10) gathering line
(11) flow line
(12) pipeline system
(13) riser base
(14) transmission line
(15) riser
(16) riser, storage system

2) This system is a total system comprised of the four subsystems of wellhead, pipeline, manifold, and riser-storage subsystems integrated in a comprehensive manner, and the capabilities and constitutive equipment are as shown in Table 1.

Anticipated Results

1) This project is an important strategy toward assuring stable oil supply

i) It will make possible active development of oil production from the continental shelf and continental slope around Japan.

ii) It will provide Japan with the necessary technological power for the development of oil resources and will enhance Japan's future bargaining power with other countries where energy policies are concerned,

2) Oil reserves (reserves capable of production) can be greatly expanded.

Oil at great ocean depths not workable by methods used in the past, permanent [probably a misprint for ice-covered] ocean oil fields, and small-scale oil fields coming under categories (iii) and (ii) described below will become capable of being developed, and the available oil resources can be expanded.

3) The economics of oil production can be enhanced.

i) Construction period can be cut down compared to the platform mode used in the past, and not only early stage production will be possible but the steel needed can be cut down, making possible more economic oil production.

ii) Small scale oil wells distributed about oil fields being worked by the platform mode can be developed by the use of a part of this system without the need to extend the platform facilities.

iii) By applying the technology on the well system that is under research and development on this system and that on pipeline systems, it will become possible to apply secondary recovery technology to wells which were thought difficult to subject to secondary recovery in the past (by forcing in gas, water), and recovery rates can be increased.

4) There is great spin-off effect of the technology

i) The range of spin-off of technology such as on marine structures, pipelines, support equipment, and remote control is very wide. At the same time, development results on as yet unknown areas such as the ocean have the potential of giving birth to high strength material, corrosion resistant material, and composite material.

ii) The developmental results from this project are expected to be applicable to development of other seabed mineral resources and sea energy development.

Table 1

subsystem	function	constitutive equipment
wellhead	this subsystem is installed at the wellhead and has the capability to control the flow of oil and natural gas and to adjust the rate of production	guidebase, wellhead equipment, valves, control devices, well equipment, covers, etc.
pipeline	this subsystem ties together wellhead equipment, manifold, and riser subsystems, transmits oil and gas produced, and serves as the pathway for pump down tool (P.D.T.)	flow line, hydraulic line, power and control cables, junction facilities, etc.
manifold	this subsystem not only collects oil and natural gas brought in by the different lines but also has the capability of accurately selecting the pathway for P.D.T. to each well unit	manifold base, manifold cellar, service capsule, P.D.T., diverters, etc.
riser, oil storage	(riser): conducts oil and natural gas from the sea bottom to the sea surface and is the pathway for P.D.T. and power sent from the surface to the bottom (oil storage): temporarily stores oil or natural gas at the surface before loading.	riser base, riser pipes, universal joint storage tank, loading facility, mooring equipment, etc.

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RESEARCH ON MAINTENANCE TECHNOLOGY

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 69-70

[Article by Toyokazu Mitsuoka, Instrument and Control Section, Systems Department, Mechanical Engineering Lab., AIST]

[Text] As oil drilling is conducted at depths greater than 100 meters and when depths of the order of 300 meters are to be drilled as in the "Seabed Oil Production System," maintenance work by divers no longer is possible.

This is why there is need to develop technology whereby a service capsule is used from which men can conduct maintenance and checks of the seabed oil production facilities and to develop maintenance work robots operated through remote control. There is particular need for the development of control technology which will enable the accurate approach of the site in mind with either the service capsule or the robot.

In addition, this type of maintenance operation cannot be conducted under normal conditions, and there is a need to introduce some degree of automation into the maintenance work. Seabed oil production has a very high possibility of creating major social problems such as ocean contamination should an accident occur, and the technology to spot such an incident quickly and to prevent such an incident is necessary.

That is to say, a facilities diagnostic technology which can discover any accident occurring within the seabed facilities or discover accidents preceding incidents before they happen or while the damage is still small in scale and prevent further damage as well as to restore system functions along with automated repair technology for automated repair of damage are necessary.

Research and development along the following lines are underway directed at the development of a seabed oil production system that will meet these objectives.

1) "Research and development on approach control technology to fixed underseas facilities" which will submerge and bring close to installations which require spot inspections such as manifolds the equipment to make the checks.

2) "Research and development on facilities diagnostic technology of pipelines" which will detect any damage or malfunctioning of pipelines and other underseas facilities at an early stage and forestall accidents.

Status of Research

"Research and Development on Approach Control Technology to Underseas Facilities"

This is research and development directed at transmitting the information necessary to enable a service capsule or other maintenance tool to approach the target site using ultrasonic waves which are the only information transmitting means in the sea. This system will be made up of a coarse directional control system effective from a remote distance, precision directional control system employing a short distance scanning ultrasonic graphic device (a type of ultrasonic television), and approach distance and speed control system.

At the present time, a coarse directional detection mode using FM ultrasonic waves has been conceived, and it has shown promise of practical application through tracking tests made in air and is presently being tested underwater.

Optimum deployment of ultrasonic wave receivers and signal treatment methods are under study on other control systems.

"Pipeline Facilities Diagnostic Technology"

Research will be conducted on a diagnostic system which will detect abnormalities such as damage or leaks to the pipelines of the seabed oil production system and estimate the degree and location of this abnormality. This diagnostic system will be made up of a system to monitor the vibrations, sounds, and pressure of the pipes and valves of the oil production system and make online abnormality detection of damages and leaks and a system to accurately examine the leak or damage through a pig (a type of capsule) in which are installed leak detection equipment or ultrasonic damage detection equipment which will follow the pipelines.

At the present time, a new method to detect oil or gas leaks with very high precision and to estimate the site of such a malfunction employing time sequence analysis of changes in pressure gradient at the inlet and outlet has been developed, and it has been established through a simple model experiment that precision one order of magnitude higher than that possible with technology of the past can be realized. This method was found to be particularly effective when pressure change noise was large in two-phase flow of oil and gas.

Studies are underway in a leak detection method in which the properties of leaking sounds radiated from the pipe wall when oil or gas leaks and sounds

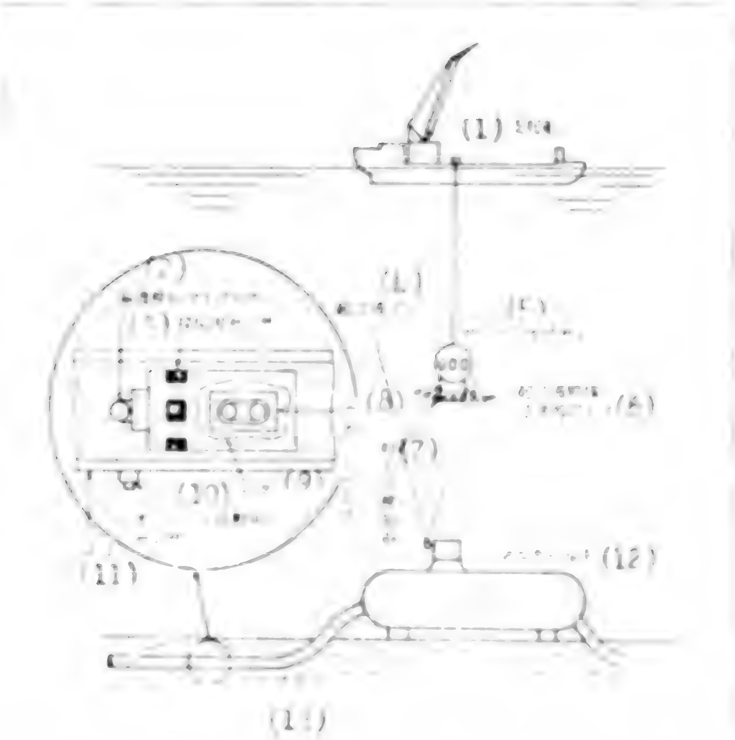

Figure 1. Approach Control Technology and Deployment of Sensors for Malfunction Diagnostic System of Pipelines

Key:
(1) support ship
(2) leak detection microphone
(3) damage sensor
(4) ultrasonic wave zone
(5) service capsule
(6) ultrasonic image reception array
(7) coarse directional detector
(8) cassette tape
(9) pig
(10) on-line diagnostic sensor
(11) pipe
(12) manifold
(13) pipeline

radiated by flowing fluids within the pipe will be analyzed where the size of the leak and the pressure differential within and without the pipe are varied.

Studies on makeup of detectors and signal detection circuits are being promoted on other systems.

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OFFICIAL INSTRUMENTATION AND CONTROL SYSTEM

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 71-73

[Article by Yoji Hasegawa, Comprehensive R and D Aide, General Affairs Department, AIST]

[Text] Development of Optical Instrumentation and Control System

Development on the "Optical Instrumentation and Control System" which was taken up as a new theme during JFY 1979 is the development of a system to measure, transmit, and control imagery information on incidents arising in a given fixed area such as within an industrial park, large chemical plant, or large steelmaking plant even in the presence of electromagnetic induction or combustible gases in safe and stable manner.

Speaking more specifically, communication modes employed in the past using wires involved systems in which current was passed through communication (transmission) cables such as copper cables (electric cables) through which sound or graphic display was sent to transmit the necessary information. An optical control system utilizing light employs glass fiber (fiberous glass) in place of the usual type of communication cable (electric cable) and uses a laser beam in place of electric current.

A measurement and control system employing light has the properties listed in Table 1, and it is expected to exploit its effects on various systems in the industrial area where the present systems are suffering as the result of various physical factors.

The Agency of Industrial Science and Technology of the Ministry of International Trade and Industry has set up an 8-year plan starting in JFY 1979 and extending to JFY 1986 to which an estimated budget of 20 billion yen is being allocated.

The budget for this year (JFY 1979) is about 51 million yen, and it is planned to draw up the conceptual design of the overall system. Actual start is expected from about October of this year.

Table 1. Features of Optical Measurement and Control System

principal merit factor	functional feature
A. use of light	no electromagnetic induction disburbance
	no short circuits
	no spark generation
	easy to ground
	no cross-talk
	small transceiver system
	no regulation by radio laws
B. use of fiber	nonelectrically conducting
	light
	slim
	easy to bend
	fire resistant
	water resistant
	corrosion resistant
	low loss
	resources conservation
	transmits visible light
	easy to prevent leaks

Background of Development of Optical Instrumentation Control System

Electronic technology which has sustained present technological developments and innovations in comprehensive manner still plays an important role in improving efficiency of economic and social activities, but the day has arrived when optical utilization technology (often called optoelectronics) has become an indispensable adjunct to enable the breakthrough of the barriers facing electronic technology.

The road to electronic technology development can be grossly classified under the following four categories.

1) Turn to high frequency (multiplex)

2) Digitization

3) Miniaturization, improved lightness, and reliability through use of solid state elements

4) Systemization

These developments made possi' ntroduction of new capabilities and expansions of application areas, a. .t may be said that the role of high frequency, adopted to speed information transmission and thereby enable greater volume transmission is very great.

At the same time, the following four points can be offered to demonstrate the difficulty of responding to the future objectives and needs for high quality and large volume information processing just by electronic technology.

1) High frequency and multiplex operations are closing in on their limits

2) Since the transmission mode is a time sequence transmission, imagery information transmission is said to be a weak point

3) System makeup is complex, and tracking and alteration are difficult

4) It is associated with the shortcoming of being poorly resistant to external noise caused by electromagnetic induction, heat, and moisture.

The recent developments in the area of semiconductor lasers, the development of optical fibers, and low-loss optical fibers have focused the footlights on optical information transmission technology as the technology to break through the wall of difficulty faced by electronic technology.

In addition to the features listed above in Table 1, optical technology has the potential of 1,000-fold multiplexing through polarization compared to the frequencies presently under utilization and overall transmission capacity 100,000 times the present all-electric transmission mode.

These advantageous features make possible more wide band use, higher speed, greater reliability, and low cost which will enable higher level of economic and social activities and bring out technological response to very complex situations as well as bring out multifaceted effects. This is why there is a need to plan to establish a new technology applying optics, and this should be a theme to be fostered as a central technology of the 1980s. These were the viewpoints which promoted the decision to conduct research and development on this theme through the large project approach.

Features and Problems in Development of the Optical Instrumentation Control System

The instrumentation control system expected to be realized through the application of light is expected to possess the features listed in Table 2. In other words, it may be said that this is a system in which the merit of applying optics is exploited to the maximum degree. In order to bring this system to reality, there is need to develop component (element) technology of the type listed in Table 3.

Image transmission, information transmission, and information processing subsystems will be built centering on development of these element technologies, and demonstration experiments are planned for JFY 1985 at a plant with a system built-in.

Table 2. Feature of Optical Instrumentation Control System Exploiting Light

feature classification	effect classification	system components, shapes	contents, types of information	quality, volume of information
features of light	broad band nature	band regions usually have considerable extra space, and terminals often can be added	large degree of multiplexing possible. A large number of terminals can be tied to a single loop	possibility created of using high speed terminals formerly limited by transmission bands
		a data base for joint use with dispersed system can be incorporated		multiple channel signals can be transmitted through multiplex mode over a single route, long lengths can be used
	wavelength multiplicity	a pathway can be used for joint transmission of different signals.	remote spectroscopy is possible	
	short wavelength property	Loop sharing and increase in junction points are easily made. Aerial electrical transmission with no word leakage is possible	images can be sent as is. Many images can be sent through image fiber	
	noninductive nature	is noise free, error check is simple, and system design, expansion, and alternation can be readily made because of no need for ground.		signal redundancy can be made small and actual information transmission speed can be raised
	no current passage	No need for potential coordination		noise free no sparks

[Table 2 continued]

<table>
<tr><th colspan="2">effect classification / feature classification</th><th colspan="2">system components, shapes</th><th colspan="2">contents, types of information</th><th>quality, volume of information</th></tr>
<tr><td rowspan="3">fiber properties</td><td>low loss</td><td colspan="2">relay distances are long, and remote points transmission is readily performed.</td><td colspan="2">energy required for measurement and control can be transmitted through light</td><td>optical energy transmission with no electromagnetic disturbance is possible</td></tr>
<tr><td>thinness and lightness</td><td colspan="2">Installation of lines is simple</td><td colspan="2">image transmission with little deterioration is possible through fiber bundles</td><td>very long transmission pathways are possible</td></tr>
<tr><td>insulated property</td><td colspan="2">no need for impedance matching at junction points
large degree of freedom in installation of transmission lines</td><td colspan="2">measurements near high voltage areas are readily made</td><td>is not sensitive to electricity
transports no surge current</td></tr>
<tr><td colspan="2">comprehensive properties of system</td><td colspan="2">versatility</td><td colspan="2">multiply functional</td><td>high speed, reliability, safety</td></tr>
<tr><td colspan="2">system mode</td><td>multiple wavelength system</td><td>wide area system</td><td>multiple terminal system</td><td>multiple layer (image) system</td><td>super high speed system</td></tr>
</table>

Table 3. Component Development Technology for Optical Control System

component	development item	application	technological subject
laser	high output laser	multiple stage multiple terminal system	new materials, new construction
	high quality beam laser	propagation through air	new construction
	wavelength control laser	multiwavelength system, spectroscopic measurements	wavelength selection technology, continuously varying wavelength technology
	polychromic laser	visual illumination	polychromic light emitting crystal technology
	long wavelength laser	spectroscopic measurements	light emitting material
fiber	single mode fiber	direct connection to high speed IC	construction, production method
	low multiple-element dispersion fiber	multiple wavelength system spectroscopic measurements	new material, doping
	long wavelength fiber	photo energy transmission	high purification of materials, fabrication technology
	image transmission fiber	raw materials, product control; crime prevention, disaster prevention	construction, production method
	functional fiber	physico-chemical peroperties, abnormality detection	materials, production method
relays	photoelectric power supply mode relay	surge current rupture protection	introduction of VLSI, high efficiency light source
	two-directional optical relay	wide area system	branching technology
	all light relay	under poor electromagnetic environment	low noise, high efficiency
	multiple wavelength optical relay	multiple wavelength system	wavelength separation technology, monolithic IC
	star coupler	multiple stage system, optical station	measurement, production method
	optical directional junction	optical station	production method

[Table 3 continued]

component	development item	application	technological subject
relays	optical wavelength discriminator	multiple wavelength station	measurement, production method
	optical mode discriminator	whole light relay	measurement, production method
	variable optical attenuator	optical station	higher precision, higher reliability
	waveguide type optical isolator	signal source stabilization	new materials
	optical switch	information control	multiple channel
	super high speed optical modulator	super high speed optical switch super high speed interface	low power
	photoamplifier	optical relay	low noise
	multiple value stabilizing nonlinear element	AD conversion, wave form restoration	new materials, new construction
	image preprocessor	extraction of image features	thin film forming technology
sensor	low voltage light detector	super high speed system	new material, new construction
	alley light detector	raw material and product control, crime prevention, disaster prevention	higher reliability
	physico-chemical quantity sensor	process measurement, abnormality detection	functional fiber development
	image sensor	product control, crime and disaster prevention	long bundle fiber, solid state sensor, scanner development
light actuator	optical power controller	electrical instrument control	development of small pulse laser of higher output and high energy resistant fiber
	photochemical reaction controller	chemical reaction control	higher stabilization and miniaturization of tunable laser
image equipment	image file	multiple stage system	practicalization of optical display
	optical display	multiple stage system	development of high quality panel display
	image processor	multiple stage system	high threshold value filter type clear line filter development

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DIFFUSION OF RESULTS, PATENT MANAGEMENT

Tokyo KOGYO GIJUTSU in Japanese Vol 20 No 8, Aug 79 pp 75-76

[Article by Morihiro Kurushima, Office of the R and D Officer, AIST]

[Text] Status on Utilization of Results

The large project system was initiated in JFY 1966, and 13 years have gone by during which time 16 projects have been launched, and a large number of results have accrued. Such outstanding results as electronic product technology including products such as LSI and IC memories, high performance new-type battery, and development of a practical seawater desalination facility have been obtained in addition to which there were 1,785 applications for Japanese industrial proprietary rights and 81 applications for foreign proprietary rights in 158 different countries which are good measures of the extent of the results of these projects. At the same time, these research results have been responsible for the inflow of 180,984,000 yen into the national treasury indicating the level of spin-off from these results.

The summary of the completed projects are described in another paper, but there have been a number of epoch making results from these projects as well as from projects now under way.

The state of utilization of the results of the different projects is described below.

1) The results of the project "High Performance Electronic Computer" completed in JFY 1971 is now being used in large computers (HITAC 8700, 8800) and for the information service system of the Nippon Telegraph and Telephone Public Corporation. It not only contributes to faster computer processing but is competing with IBM's world enterprise in representing the research and development strength of Japan's computer industry and help establishing a foothold in the market. It is also serving as the foundation for present semiconductor technology.

2) "Desulfurization Technology" also completed in the same JFY 1971 has been utilized at the Kashima Power Plant of Tokyo Electric (Co.) and the Yokkaichi Power Plant of Chubu Power where it is contributing to pollution prevention.

3) The "Electric Automobile" project which was completed in JFY 1977 has capabilities rivaling those of the gasoline automobile and has made possible production of high performance and long life batteries. These developments also are evaluated very highly from a social standpoint, and future popular use is expected. At the same time, the large power transistor developed for control purposes is being utilized in various areas such as for power supply control devices.

4) The project "Sea Water Desalination and Utilization of Byproducts" completed in JFY 1978 developed a large scale desalination plant (100,000 m^3/h, which can supply the needs of a city of 200,000-300,000 people) which is the most recent and best of the desalination plants in the world. It not only has evoked considerable appreciation in Japan but is now installed as a desalination unit in water-poor Saudi Arabia and Kuwait.

Handling of Results

The results emanating from the progress made by large project research and development as well as research results obtained at the research organs under the Agency of Industrial Science and Technology and other government ministries and agencies are naturally the property of the government. Even those results obtained from research contracted to private companies (industrial proprietary rights such as patents, knowhow so designated by the Agency director) are also the property of the nation.

When these results of research and development are such that these are adaptable to industrial policies where they can be incorporated into executional plans and also fulfill requests for public well being and the requestor fulfills the conditions of possessing technological and economic capabilities of utilizing these results, a use permit is granted. Particularly in the situation where there are no mitigating circumstances, the contractor firm will be given exclusive use. Where use fees are concerned, the usual patent use fees apply.

The Agency of Industrial Science and Technology serves to widely disseminate the results of research coming out of the various governmental research organs under the Agency and other government ministries and agencies and founded the Japan Industrial Technology Promotion Council in 1969 for the purpose of establishing a bridge between the laboratories and the people*. This group is also actively engaged in disseminating the results of the various large project research and development results to the industrial world. To this end such material is being prepared for this group, and these are then passed out to prospective utilizers after they have undergone the necessary formalities (see Figure 1).

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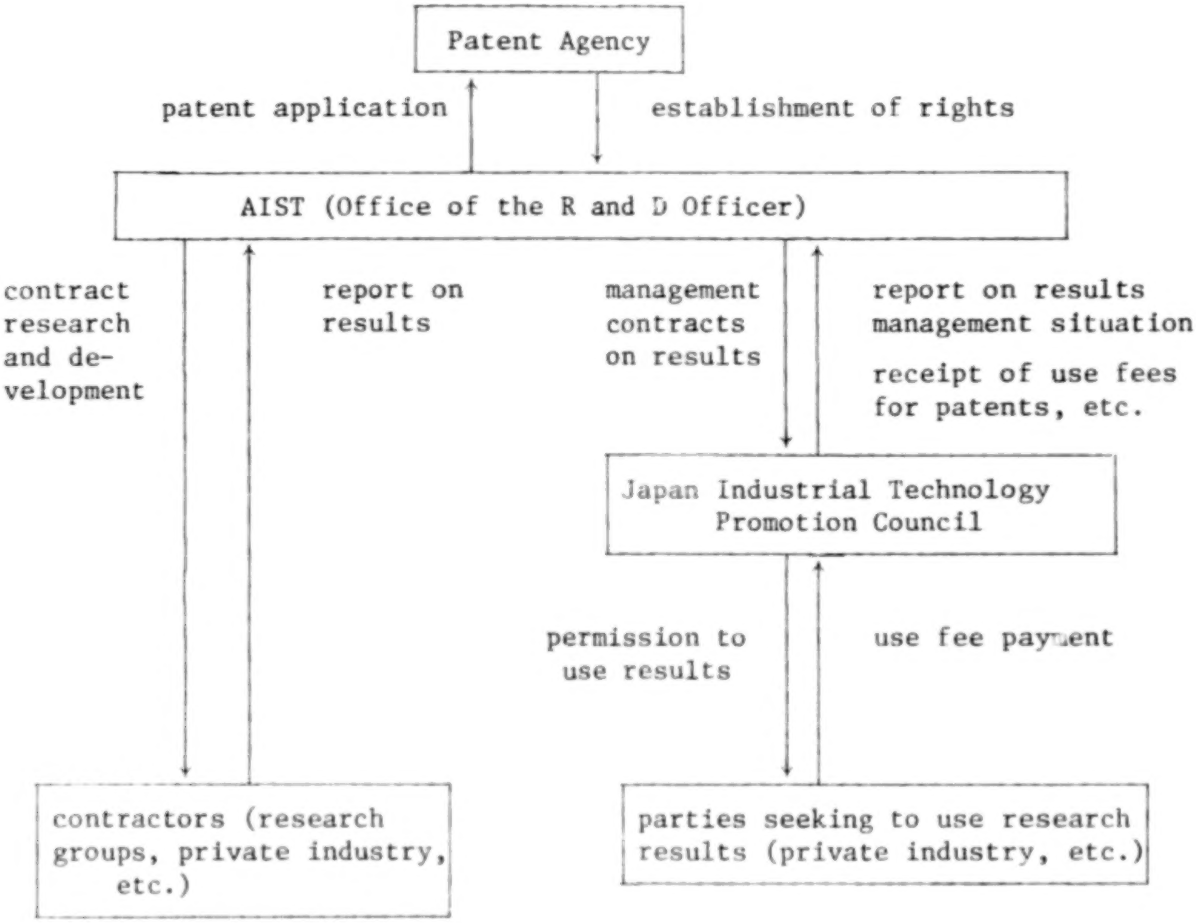
Patent Agency
patent application
establishment of rights
AIST (Office of the R and D Officer)
contract research and development
report on results
management contracts on results
report on results management situation
receipt of use fees for patents, etc.
Japan Industrial Technology Promotion Council
permission to use results
use fee payment
contractors (research groups, private industry, etc.)
parties seeking to use research results (private industry, etc.)

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